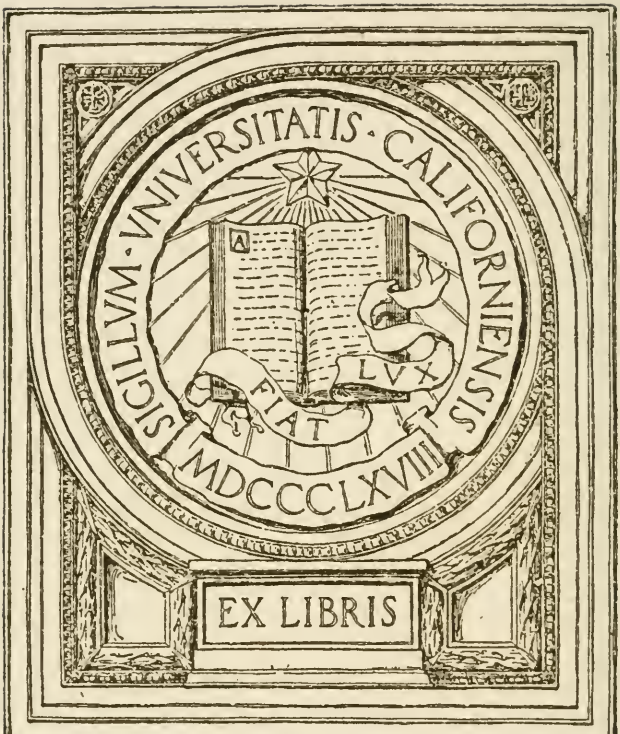

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

INSTRUCTIONS TO FIELD PARTIES

AND

DESCRIPTIONS OF SOIL TYPES.

FIELD SEASON, 1904.

U. S. DEPARTMENT OF AGRICULTURE,

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AND

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1904

JULY.

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1905

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OCTOBER.

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NOVEMBER.

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DECEMBER.

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NOTE.

The accompanying instructions have been prepared for the use of field men of the Bureau of Soils. The material on fiscal regulations is in addition to the Fiscal Regulations as issued by the Division of Accounts and Disbursements and should be taken as supplementary to these Department Regulations. All field men should be careful that their accounts conform strictly to these regulations.

The descriptions of soil types are given as an aid to the field parties in correlation of soil types and should be carefully studied to this end. Soils of a new area should be correlated with known types where this is possible.

MILTON WHITNEY,
Chief of Bureau.

WASHINGTON, D. C., *June 7, 1904.*

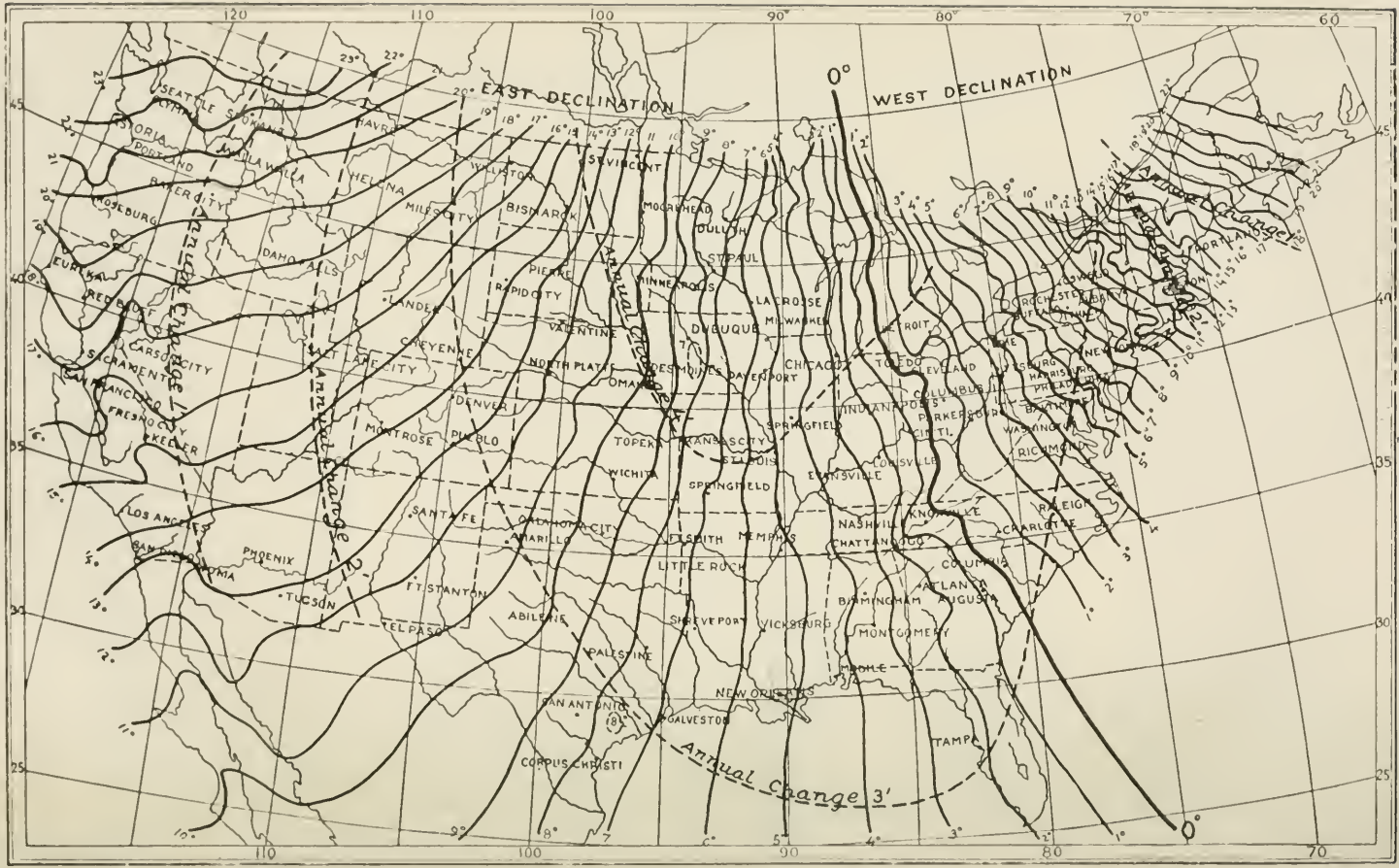

FIG. 1.—Chart of equal magnetic declinations. January, 1902.

CONTENTS.

ILLUSTRATION.

INSTRUCTIONS TO FIELD PARTIES AND DESCRIPTIONS OF SOIL TYPES.

INSTRUCTIONS TO FIELD PARTIES.

Fiscal regulations.—The pamphlet on "Fiscal Regulations of the Department of Agriculture" issued by the Division of Accounts and Disbursements applies to all fiscal matters of this Bureau, with certain modifications and additions given below. Field agents of this Bureau should carefully read the regulations and conform literally to the instructions given there. Monthly accounts are frequently delayed in payment because of the failure to conform to the rules of the Department. Delays of this character can be entirely avoided if field men are careful to have all accounts conform literally to instructions given in the Fiscal Regulations and to make explanation of all items of expenditure on the subvouchers. All expenses not accompanied by subvouchers (subvouchers must be submitted for purchases amounting to $1 or more) should be fully explained in a memorandum attached to voucher. Charges for lodging and team hire must always be supported by subvoucher.

Duplicate vouchers on Form 4, with subvouchers (Forms 4a, 4b, 4c) are to be submitted promptly at the end of each month, properly filled out, and signed before a notary. The receipt and oath should be signed on each voucher in all cases, but the notary's signature and seal should be on but one voucher. Every voucher for reimbursements of traveling expenses must be accompanied by Form 4c, showing what portion of the travel has been performed on transportation requests. When no requests have been used a blank form properly signed should be filed with the voucher, and a statement made on this form showing that no transportation requests were used.

Authorization to travel.—An authorization from the Chief of the Bureau of Soils must be obtained before any travel is performed for the Department, and written or telegraphic authorization must be obtained for all travel outside of an area or where unusual expense or additional travel is necessary.

Transportation.—Travel to and from areas should be performed on transportation requests where the cost of travel amounts to $3 or more. (See Fiscal Regulation No. 15.) West of the Mississippi River all travel should be performed on transportation requests on bond-aided or land-grant railroads. Transportation requests will be furnished on application to the chief clerk of the Bureau. Applications for these requests should be made at least one week before the travel is to be performed. In filling out transportation requests, before presenting to ticket agent, be sure to fill in all blanks upon the face of the request. The stub on end of request is to be filled out when the request is issued and returned at once to the Bureau of Soils.

Freight and express.—When express charges are included in an expense account, the original express receipt must be attached to the subvoucher. Express charges to Washington, D. C., should not be prepaid, but the shipments should be made "collect."

When possible, shipments should be made by freight rather than by express. Shipments by freight from points west of the Mississippi River should be made according to Fiscal Regulation No. 14. The property to be sent should be securely packed, and notice should be given to the Chief of the Bureau, fully describing the property and giving the full name and address on the package, with the name of the person in whose care the property is stored.

When it is necessary to pay excess-baggage charges, statement should be made on the face of the subvoucher that the excess consists of Government property, and the original receipt for the money paid must accompany the expense account.

Allowances for field parties.—While engaged in actual travel the limits of expense should be governed by Fiscal Regulation No. 12. While in an area engaged in field work not more than $1.50 per day per man on an average is to be paid for subsistence; when possible, cheaper rates should be secured.

The usual rate for hire of horse and buggy is $1.50 per day. This rate should not be exceeded, except where actually necessary. If it is found that proper conveyances can not be secured in an area at this price the fact must be made known to the Chief of the Bureau at once.

When the party remains at one place for a period of more than one week, cheaper rates by the week can nearly always be secured. Advantage should be taken of such weekly rates. When boarding at reduced rates it sometimes happens that the party is away from the regular boarding place for one or more meals, or perhaps an entire day. The Fiscal Regulations explicitly state that subsistence expenses can not be allowed at more than one place, but it has been ruled that when reduced rates are being paid subsistence expenses will be allowed for short periods away from the regular boarding place, provided the extra expense plus the reduced rate does not exceed the week rate calculated at the regular day rate. Thus, if a party is living at a hotel or boarding house, the regular rates of which are $2 per day, and by reason of staying for one week or longer a rate of $1.50 per day is secured, and it should happen that the party could not get back to the hotel, but took meals or lodging away (paying for the meals or lodging), the cost of these would be allowed, provided the entire week's expenses did not amount to more than $14. Duplicate charges of this character are allowed only in the interest of economy, and should not be incurred, except when absolutely necessary. Where such duplicate charges are made, a full explanation must be made satisfactory to the Chief of the Bureau and the disbursing officer.

Subvouchers for team hire.—The following form shows a subvoucher for team hire completely filled out. All such subvouchers should describe rig, state dates used and number of hours in use, give distance traveled, and use to which team was put. In case a team is used on Sunday or a holiday, the reason for using it should be stated.

Form No. 4*b*. Subvoucher No. 1.

$7.50. (City or town) COLUMBUS, OHIO,
(Date) *Dec. 27, 1901.*

Received of John Smith, U. S. Department of Agriculture, seven and $\frac{50}{100}$ dollars.

For hire of horse and buggy for use in soil mapping, Dec. 23, 24, 25, 26, and 27, five days, at $1.50 per day..... $7.50
In use 8 hours per day. Averaged distance traveled, 20 miles.

Team used on Dec. 25 was on official business.

(Signature) JAMES SCOTT,
(Title) *Owner of team.*

Signatures to subvouchers.—Fiscal Regulation No. 25 contains explicit instructions regarding the signatures to subvouchers. Care should be taken that all signatures conform to these instructions. All signatures must be written in ink. The name of the person signing the receipt must appear upon the receipt, and the authority for signing must appear in the title, which must be written by the signer below his name. Where a subvoucher is signed by mark, one disinterested witness should sign the subvoucher and give his address. When a firm name or a hotel name is signed to a subvoucher, the full name and title of the person receiving the money must also be given.

Laundry.—With regard to the item of laundry in expense accounts where parties are located for any length of time at a particular point, it is usually possible to make arrangements by which laundry may be done at a fixed price, usually about 50 cents per week per person, and wherever this is practicable it should be done. It will, however, happen that parties who are traveling or are moving their headquarters frequently will be unable to make arrangements of this kind, and in such cases the expense for laundry will necessarily exceed this amount; in no case, however, must the charge for laundry exceed $4 per person per month, and expense accounts containing charges in excess of this amount will be corrected. While the Fiscal Regulations provide for a maximum of $4 per month to cover laundry expenses of employees in the field, this contemplates the reimbursement only of actual amounts paid, and the items for laundry must be inserted in the account on the dates paid in actual amounts just the same as the other expenses.

Such items must not be averaged at the end of the month, and the amount for each member of the party must be shown as a separate item.

Telegrams.—Telegrams sent at Government rates should refer only to official business. The Treasury Department has ruled, however, that chiefs of parties who are responsible for the accounts of the party may telegraph in regard to salary checks or expense-account checks which have been delayed, when the money is needed for use in defraying the expenses of the party. Such telegrams, however, should not be sent except when the delayed check has been awaited a reasonable time. Telegrams regarding leave should not be sent at Government rates or charged to the Department.

The Chief of the Bureau should be informed by telegraph of every change in address of the party in the field. In sending telegrams to the Bureau, address "Soils, Washington, D. C.," and sign the telegrams by last name only.

Location of headquarters while in field.—The attention of the assistants of the Bureau of Soils is directed to the advisability and real necessity of keeping as near as possible to their field of operations. In no case where it can be avoided should a man be located at a greater distance than 6 miles from the area to be surveyed, as 12 miles distance there and back, added to the day's work, is a material hardship on the team, and reduces considerably the amount of work that can be done in the course of the day.

For the most part the field work of the Bureau is carried on in well-settled districts, where it should be possible to obtain board and lodging, for a few days at least, in farmhouses, provided there are no hotels or lodging houses convenient to the area to be surveyed.

There is no objection to obtaining rates by the week, and this is advisable where the place is conveniently located for the work, and will be found cheaper than paying by the day, but no longer term should be provided for, except in certain circumstances, as in most cases a field party should be able to survey a sufficient area in one or two weeks to warrant a removal to some more convenient place. It happens at times, however, that for lack of accommodations a

longer time than this has to be spent in one locality or else a camp outfit be provided. The Fiscal Regulation No. 12 of the Department provides that board and lodging can only be paid for a period not to exceed thirty days in any one locality, and this regulation holds against the field assistants in this Bureau, except that where suitable accommodations can not be obtained and camp outfits are not provided, the Secretary of Agriculture (in letter of authorization No. 74) has empowered the Chief of the Bureau to grant an extension of time in which board and lodging will be allowed in any one locality to sixty days, or to any shorter term within his discretion.

When from any cause it is considered necessary or advisable to remain in one place for a period exceeding thirty days, the Chief of the Bureau must be notified and satisfactory reasons given him why the party should remain longer than thirty days, and if in his judgment the reasons are sufficient, the length of time will be extended and the disbursing office notified of the fact, so that the accounts will be passed in that office. Such action must be taken specifically for each case, and the request for an extension of time must be mailed a sufficient length of time in advance to allow of action being taken. Otherwise in no case will the board and lodging be allowed in any one locality for a period exceeding thirty days.

Accidents to parties.—The following general instructions are issued for the guidance of field men of the Bureau of Soils, in the event of possible accidents to teams or vehicles that may be hired by them for official use in the field.

Should an accident occur which results in any damage to a horse or vehicle under your care, and if such accident is due to carelessness or fault on your part, or that of your assistants, it will be considered a personal responsibility of your own, and you will be expected to make the necessary settlement with the owner. The settlement will devolve upon you in the event of the accident being due to fast or reckless driving, excessive use, or in any other case in which you can not show that proper judgment and care and reasonable precautions have been used.

If an accident should be due to causes for which you are not responsible it might constitute a claim against the Government, and if such claim was approved by the Department, the matter would be referred to Congress for an appropriation to reimburse the owner.

In such cases you are cautioned *not to pay the claim*, but to refer the matter to this Department; payment of such claim by you would constitute prima facie evidence that the accident was due to carelessness on your part, and the matter could not then be handled by the Department. Should the horse be taken sick, or if an unforeseen and unavoidable accident should occur to either horse or vehicle while in the employ of the Department, claim should be made, accompanied by affidavits, properly sworn to, setting forth all the facts of the case and substantiated in every possible way by disinterested witnesses.

The greatest care is enjoined upon all representatives of the Bureau in the care of teams and in their safe delivery to owners after use.

Settlement of claims of this kind through Congress are very troublesome and tedious, and they should not be presented to the Department if it is possible to avoid it, and then not unless it involves considerable money and is accompanied by strong and irrefutable evidence that the Department agent is not responsible. Such claims will be scrutinized very carefully before being acted upon by this Department.

Six-months' reports.—On the 1st of July and 1st of January of each year a report upon Form No. 41 of this Bureau should be made out by each assistant in charge of party and forwarded to the Chief of the Bureau. This report shows the area surveyed in each district, the cost per square mile, and the actual time given to the survey. In order that assistants may make out this report, memorandums should be kept of all expenses. In calculating cost of work include salaries, subsistence while in the area, and team hire, with any necessary miscellaneous expenses. Transportation expenses (which include railroad fare, sleeping-car fare, meals en route, etc.) should not be included in calculating cost per square mile. The salary should also only be calculated for the time actually spent in the area.

INSTRUCTIONS FOR MAPPING SOILS AND ALKALI.

Organization of field party.—A field party in the soil survey usually consists of two men—an assistant in charge of party and a field assistant. The assistant in charge of party shall control all field work of the party, prepare the report and maps, carry on

all correspondence necessary to the conduct of the survey, pay all field expenses of the party, and forward monthly expense accounts to the office of the Bureau in Washington. The field assistant shall perform all duties required of him by the assistant in charge.

The organization of the Bureau has reached a point where it is no longer possible to put all the experienced men of the field force in charge of parties, while it is desirable that each member of the force should have the duties and responsibilities of the charge of a party for at least a part of the year. It will be necessary, therefore, occasionally to put men of equal experience in the same assignment, or to give men of less experience assistants who have been longer in the service. In such cases it is expected that the men will cheerfully share the responsibilities and details of the work, and show a spirit of real collaboration. So far as possible each man of experience will be given charge of a party for at least one assignment each year.

Prosecution of field work.—All mapping should be on a scale of 1 inch to 1 mile. Where possible, base maps on this scale will be furnished all field parties before entering the field. Wherever such maps are supplied it is supposed that they are the most reliable and complete maps obtainable. Field parties should endeavor to correct the base map if it is found in error. Frequent check upon directions should be made with the compass, and all distances on roads are to be measured with the odometer. Where from the nature of the error it is found impossible to make correction, the soil map should conform to the base used, but careful note should be made of all such errors, so that in case a revised edition of the map is published the correction can be made without a resurvey of the soils.

Establishing soil types.—At the end of this pamphlet is given a concise description of all the types of soil described by this Bureau up to December 31, 1903. In establishing types in an area this list should be carefully consulted, and where possible all soils are to be correlated with types there described. As soon as a type is determined upon, whether new or previously described, a description of it should be sent to the Bureau on Form 46. The selection of a provisional name for each soil type should be made, and in all correspondence and reports this name should be used when speaking of the type.

In the humid portions of the country the description of a soil type covers the materials to a depth of 3 feet, and in the semiarid and arid regions to a depth of 6 feet. The type name covers the entire profile. Where there occurs, as a subsoil, material which if exposed at the surface would be called Fresno sand, for instance, it is not proper to speak of this subsoil as Fresno sand, but as material similar to the Fresno sand. Where this material is covered by a loam or silt loam, for example, within a depth of 3 to 6 feet, it loses its identity as the Fresno sand and is an integral part of the new type established.

Correlation of soil types.—It is very desirable, from all points of view, that close attention be paid to the correlation of soils. It is very undesirable to increase the number of soil types more than is necessary, and wherever a soil can consistently be put under an established type it should be done. Much advance has been made in the past year in this matter of correlation and in using the names of soils to bring out their relations. Several of the original types have been merged into others, or have been given new names to bring them into a uniform series, where this could be done without danger of confusion. In doing this the object has been to establish certain series in the different physiographic divisions of the United States, and we are finding that there are a few general classes of soils that are in a way related.

Due caution must be observed in this matter of correlation, but a greater latitude may be taken in correlating soils of widely separated areas than at first would appear possible, from the fact that the soil of each area is fully described in all its characteristic and special features. A soil, to be correlated with a type, must conform to it in certain broad, general features, but it may differ in some unessential details. The descriptions of the soil types given in this publication must not be taken as rigid specifications of the conditions which must be found in certain types in all areas. The description is of necessity general, and in the nature of the case can not be specific in all particulars.

Every effort has been made to group the soils into series for the purpose of bringing out more clearly the relationship of the different types, and their relative agricultural value. The grouping has also been made with a view to reduce the number of local

type names. If the field men acquaint themselves with the general characteristics of these series, they will find it a great aid in placing soils of new areas. Furthermore, if any type in a series is thoroughly understood, the remaining types can be called to mind without reference to the printed description, thereby reducing the number of type descriptions necessary to be carried in the head.

To complete the Norfolk series, the Susquehanna gravel has been changed to Norfolk gravel, the Windsor sand to Norfolk coarse sand, the Windsor sandy loam, encountered for the first time in 1903, to the Norfolk coarse sandy loam, and the Sassafras loam to the Norfolk silt loam. This practically perfects the series. Several of the old local names have been dropped as the true relationship of these soils to the Norfolk series has become apparent. Similar work has been done with the other principal series, so that many of them now are practically complete, having a stony loam, gravel, gravelly loam, sand, fine sand, sandy loam, fine sandy loam, loam, silt loam, clay loam, and clay, of related materials.

The grouping of the soils in these series is not only a great aid in correlation, but it is entirely logical. When the Norfolk sand is being deposited, the conditions somewhere in the area will undoubtedly be favorable to the deposition of gravel, of silt, of fine sand, of loam, and of clay, and wherever material of these characters is encountered, presumably coming from the same source and being deposited essentially at the same time and in the same manner, it should be given this distinctive name so as to show the relation of the soils to one another. Knowing as we do the processes of soil formation, either from the disintegration of rocks in place or through transportation by wind or water, we should expect that materials from the same source would differ in their texture. The relationship of the derived soils should be shown by the use of a common name.

There will be found in nearly all areas soils of local origin and of exceptional character which will have to be given local names, but so far as possible the soils encountered in new areas should be correlated with established types, preference being given where possible to some of the great series described hereafter. As a rule, a series should be confined to certain physiographic areas, that is, the names of the Coastal Plain soils should not be carried over

into the Piedmont or into the Glacial areas, unless the character of the material and its mode of formation as well as its agricultural value are sensibly the same. For example, in 1902 the name Alloway clay, which was originally used in the Coastal Plain, was approved for a soil having exactly the same texture and precisely the same mode of formation in a river delta in one of the New York areas within the limits of the drift. Also in 1903 several of the Coastal Plain soils, as, for example, the Norfolk sand, Norfolk sandy loam, and Elkton clay, were recognized in the valley of the Susquehanna River in Pennsylvania and in the limestone region of northern Kentucky, the materials being similar to those found on the Atlantic Coastal Plain and, in fact, being the same materials in their progress to the Coastal Plains region.

The following are the principal series so far established:

Galveston series.—The coastal beaches and marshes.

Norfolk series.—Light-colored material, with yellow sand or sandy clay subsoils, in the Coastal Plain.

Portsmouth series.—Dark-colored material, with yellow mottled gray sand or sandy clay subsoils, in the Coastal Plain.

Orangeburg series.—Gray to red sand or loam with red sandy clay subsoil, in the Coastal Plain.

Houston series.—Gray or black calcareous prairies in the Coastal Plain.

Vernon series.—Red sand, loam, and clay, typical of the Permian formation.

Yazoo series.—Dark, silty soils of the flood plain of the Mississippi River and its larger tributaries.

Cecil series.—Gray to red sand or loam, with bright-red clay subsoil, derived from igneous or metamorphic rocks of the Piedmont Plateau.

Penn series.—Dark Indian-red sand or loam, with loam or clay subsoil of same color. Derived from red sandstone and shale of the Piedmont Plateau.

Porters series.—Gray to red sand to loam, with red clay subsoil, derived from granitic rocks of the Appalachian Mountains.

De Kalb series.—Yellow sand and loam, with heavier subsoil of the same color, derived from sandstone of the Appalachian Mountain and Cumberland Plateau.

Hagerstown series.—Yellow to red sand and loam, with clay subsoil of same color, derived from massive limestone, in residual valleys and uplands.

Fort Payne series.—Light-colored, usually yellow, sand and loam, resting on clay of same color; both soil and subsoil usually very cherty. Derived principally from Knox dolomite (magnesium limestone).

Clarksville series.—Soil of varying colors, with a distinctive red or yellow subsoil derived mainly from the limestone of the St. Louis group.

Miami series.—Light-colored sand and loam, resting on light-colored glacial till or loess of the glaciated and loessial areas.

Marshall series.—Dark-colored sand and loam, resting generally on light-colored glacial till or loess of the glaciated or loessial areas. Generally upland areas.

Sioux series.—Dark-colored material resting on dark or light colored subsoils, with gravel beds within 3 feet of the surface. Occupying river bottoms in the glaciated area.

Dunkirk series.—Dark-colored material found on the glacial beaches around the Great Lakes.

Oswego series.—Residual prairie soils derived from interbedded sandstone, limestone, and shale.

Sedgwick series.—Origin not clearly understood; the soils may possibly not be related.

Maricopa series.—Colluvial wash from granitic hills. Inter-mountain and Pacific Coast States.

Fresno series.—Alluvial wash of granitic material. Inter-mountain and Pacific coast.

Yakima series.—Derived from basaltic material and volcanic ash. Pacific coast.

Redfield series.—Residual or alluvial, from red sandstone strata of the far West.

Oxnard series.—River, delta, and coast valley soils of sandstone and shale material. Pacific coast.

Billings series.—Interior valley soils derived from sandstone and shale of the Great Plains.

Salt Lake series.—Lacustrine deposits, typically developed around the Great Salt Lake.

Pecos series.—Alluvial, highly calcareous soils of the far West.

Imperial series.—Delta soils of the Colorado Desert.

Salem series.—Derived from interbedded red sandstone, shale, and highly ferruginous basalt. Pacific coast.

San Luis series.—Lacustrine deposits of volcanic rock material, underlain by gravel within 3 or 4 feet. Inter-mountain valleys.

Scheme of soil classification.—While it is not possible to make a rigid classification of soils from the mechanical analyses, much may be done to systematize and bring into uniformity the classification of soils by the different field parties. The following scheme seems to fit very closely the best field classification, and has been made up from the examination of several thousand samples which have been described by the field men and analyzed in the physical laboratory of the Bureau.

Coarse sand contains more than 20 per cent of coarse sand and more than 50 per cent of fine gravel, coarse sand, and medium sand, less than 10 per cent of very fine sand, less than 15 per cent of silt, less than 10 per cent of clay, and less than 20 per cent of silt and clay.

Medium sand contains less than 10 per cent of fine gravel, more than 50 per cent of coarse, medium, and fine sand, less than 10 per cent of very fine sand, less than 15 per cent of silt, less than 10 per cent of clay, and less than 20 per cent of silt and clay.

Fine sand contains less than 10 per cent of fine gravel and coarse sand, more than 50 per cent of fine and very fine sand, less than 15 per cent of silt, less than 10 per cent of clay, and less than 20 per cent of silt and clay.

Sandy loam contains more than 20 per cent of fine gravel, coarse sand, and medium sand, more than 20 per cent and less than 35 per cent of silt, less than 15 per cent of clay, and less than 50 per cent of silt and clay.

Fine sandy loam contains more than 40 per cent of fine and very fine sand and more than 20 per cent and less than 50 per cent of silt and clay, usually containing 10 to 35 per cent of silt and from 5 to 15 per cent of clay.

Silt loam contains more than 55 per cent of silt and less than 25 per cent of clay.

Loam contains less than 55 per cent of silt, and more than 50 per cent of silt and clay, usually containing from 15 to 25 per cent of clay.

Clay loam contains from 25 to 55 per cent of silt, 25 to 35 per cent of clay, and more than 60 per cent of silt and clay.

Clay contains more than 35 per cent of clay.

Sandy clay contains more than 30 per cent of coarse, medium, and fine sand, less than 25 per cent of silt, more than 20 per cent of clay, and less than 60 per cent of silt and clay.

Silt clay contains more than 55 per cent of silt and from 25 to 35 per cent of clay.

The following table contains the same information differently arranged and may prove of more use to some of the field men:

Scheme of soil classification based upon the mechanical composition of soils.

<table>
<tr><th>Class.</th><th>1.
2–1</th><th>2.
1–.5</th><th>3.
.5–.25</th><th>4.
.25–.1</th><th>5.
.1–.05</th><th>6.
.05–.005</th><th>7.
.005–0</th></tr>
<tr><td rowspan="2">Coarse sand.</td><td rowspan="2"></td><td rowspan="2">More than 20 per cent of 2.</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">Less than 10 per cent of 5.</td><td>0–15</td><td>0–10</td></tr>
<tr><td colspan="3">More than 50 per cent of 1+2+3.</td><td colspan="2">Less than 20 per cent of 6+7.</td></tr>
<tr><td>Medium sand.</td><td>Less than 10 per cent of 1.</td><td colspan="3">More than 50 per cent of 2+3+4.</td><td>Less than 10 per cent of 5.</td><td>0–15</td><td>0–10</td></tr>
<tr><td colspan="5"></td><td colspan="2">Less than 20 per cent of 6+7.</td></tr>
<tr><td rowspan="2">Fine sand.</td><td colspan="3" rowspan="2">Less than 10 per cent of 1+2.</td><td colspan="2" rowspan="2">More than 50 per cent of 4+5.</td><td>0–15</td><td>0–10</td></tr>
<tr><td colspan="2">Less than 20 per cent of 6+7.</td></tr>
<tr><td rowspan="2">Sandy loam.</td><td colspan="3" rowspan="2">More than 20 per cent of 1+2+3.</td><td rowspan="2"></td><td rowspan="2"></td><td>10–35</td><td>5–15</td></tr>
<tr><td colspan="2">More than 20 per cent, and less than 50 per cent of 6+7.</td></tr>
</table>

Scheme of soil classification, etc.—Continued.

Class.	1. 2-1	2. 1-.5	3. .5-.25	4. .25-.1	5. .1-.05	6. .05-.005	7. .005-0
Fine sandy loam.				More than 40 per cent of 4+5.		10-35	5-15
						More than 20 per cent and less than 50 per cent of 6+7.	
Loam.							15-25
						Less than 55 per cent of 6.	
						More than 50 per cent of 6+7.	
Silt loam.						More than 55 per cent of 6.	Less than 25 per cent of 7.
Clay loam.						25-55	25-35
						More than 60 per cent of 6+7.	
Sandy clay.		More than 30 per cent of 2+3+4.				Less than 25 per cent of 6.	More than 20 per cent of 7.
						Less than 60 per cent of 6+7.	
Silt clay.						More than 55 per cent of 6.	25-35 per cent of 7.
Clay.						More than 35 per cent of 6+7.	

Outfit for work.—The outfit for field work consists of the following:

Soil auger, 40-inch handle.
Geologist's hammer.
Notebooks.
Compass or plane table.
Odometer.
Chain scale.
Set of colored pencils.
Base map.
Sacks and tags for collecting samples of soil.
Cards for reporting samples collected (Forms 46, 47, 48).
Copy of Field Instructions.

In addition to the above certain parties should add:

Alkali outfit.
Extension auger and pipe wrenches.
Filter pump.
Metallic tape 50 feet long.

These supplies are to be obtained on application to the property clerk of the Bureau, countersigned by the chief clerk. Memorandum receipts are taken by him for all supplies issued. Additional supplies, stationery, etc., needed while in the field are to be ordered on card, Form 43. The loss of, or damage to, any supplies should be at once reported to the chief clerk, with an explanation of the cause of such loss or damage.

Odometer.—The Bell odometer has been adopted for use in all measurements. The instrument should be clamped to the axle of the vehicle by the band which supports the shafts. The iron pin is driven in the end of the hub and is bent so that as the wheel revolves the end of the pin just strikes the swell of the cogwheel on the odometer. If the instrument is carefully adjusted very little trouble is experienced in its use. The red hand revolves once every mile, giving the fractions of a mile, each space representing one-fortieth of a mile, or 8 rods. Each revolution of the red hand moves the yellow hand one space, representing the miles up to 40 in one revolution around the dial, and shown by the inside figures. Each revolution of the yellow hand moves the black hand one space, each space representing 40 miles, and shown by the outside figures. The sum of the indications of the three hands gives the

mileage. Each odometer is adapted to but one sized wheel. In case it is impossible to obtain a vehicle with a wheel of the proper size for the odometer you have, the readings must be corrected in order to read miles. Should any other sized wheel be used, the following formula will enable the proper correction to be made:

$$x=\frac{ad}{d_1}$$

Where x is distance traversed in fortieths of a mile, d is the diameter of the wheel to be used, d_1 is the diameter of wheel to which the odometer is adapted, and a is number of dial divisions as read from odometer.

The instruments furnished by this Bureau are nearly all adapted to a 42-inch wheel. The following table will enable the proper correction to be made when any other than a 42-inch wheel is used. The figures in the first column are the dial divisions as read from the odometer, and the figures in the other columns give the distance traveled in fortieths of a mile. Chain scales divided into forty parts to an inch are supplied for convenience in platting distances as measured or calculated in this table.

Table for reducing odometer readings to fortieths of a mile.

Dial divisions.	Wheel diameter—inches.							
	38	39	40	41	43	44	45	46
1	0.9	0.9	1.0	1.0	1.0	1.0	1.1	1.1
2	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2
3	2.7	2.8	2.9	2.9	3.1	3.1	3.2	3.3
4	3.6	3.7	3.8	3.9	4.1	4.2	4.3	4.4
5	4.5	4.6	4.8	4.9	5.1	5.2	5.4	5.5
6	5.4	5.6	5.7	5.9	6.1	6.3	6.4	6.6
7	6.3	6.5	6.7	6.8	7.1	7.3	7.5	7.7
8	7.2	7.4	7.6	7.8	8.2	8.4	8.6	8.8
9	8.1	8.4	8.6	8.8	9.2	9.4	9.6	9.9
10	9.0	9.3	9.5	9.8	10.2	10.5	10.7	11.0
11	9.9	10.2	10.5	10.7	11.3	11.5	11.8	12.0
12	10.8	11.1	11.4	11.7	12.3	12.6	12.8	13.2
13	11.7	12.1	12.4	12.7	13.3	13.6	13.9	14.2
14	12.6	13.0	13.3	13.7	14.3	14.7	15.0	15.3
15	13.5	13.9	14.3	14.6	15.3	15.7	16.1	16.4

Table for reducing odometer readings to fortieths of a mile—Cont'd.

Dial divisions.	Wheel diameter—inches.							
	38	39	40	41	43	44	45	46
16	14.4	14.8	15.2	15.6	16.4	16.8	17.1	17.5
17	15.3	15.8	16.2	16.6	17.4	17.8	18.2	18.6
18	16.3	16.7	17.1	17.6	18.4	18.8	19.3	19.7
19	17.2	17.6	18.1	18.5	19.4	19.9	20.3	20.8
20	18.1	18.6	19.1	19.5	20.5	20.9	21.4	21.9
21	19.0	19.5	20.0	20.5	21.5	22.0	22.5	23.0
22	19.9	20.4	20.9	21.4	22.5	23.0	23.5	24.1
23	20.8	21.3	21.9	22.4	23.5	24.1	24.6	25.2
24	21.7	22.3	22.8	23.4	24.5	25.1	25.7	26.3
25	22.6	23.2	23.8	24.4	25.6	26.2	26.8	27.4
26	23.5	24.1	24.7	25.4	26.6	27.2	27.8	28.5
27	24.4	25.1	25.7	26.4	27.6	28.3	28.9	29.6
28	25.3	26.0	26.6	27.3	28.6	29.3	30.0	30.7
29	26.2	26.9	27.6	28.3	29.7	30.4	31.1	31.8
30	27.1	27.8	28.6	29.3	30.7	31.4	32.1	32.9
31	28.0	28.8	29.5	30.3	31.7	32.5	33.2	33.9
32	28.9	29.7	30.4	31.2	32.7	33.5	34.3	35.0
33	29.8	30.6	31.4	32.2	33.8	34.6	35.3	36.1
34	30.7	31.6	32.4	33.2	34.8	35.6	36.4	37.2
35	31.6	32.5	33.3	34.2	35.8	36.6	37.5	38.3
36	32.5	33.4	34.3	35.1	36.8	37.7	38.6	39.4
37	33.4	34.3	35.2	36.1	37.9	38.7	39.6	40.5
38	34.4	35.3	36.2	37.1	38.9	39.8	40.7	41.6
39	35.3	36.2	37.1	38.1	39.9	40.8	41.8	42.7
40	36.2	37.1	38.1	39.0	40.9	41.9	42.8	43.8
41	37.1	38.0	39.0	40.0	41.9	42.9	43.9	44.9
42	38.0	39.0	40.0	41.0	43.0	44.0	45.0	46.0
43	38.9	39.9	40.9	42.0	44.0	45.0	46.1	47.1
44	39.8	40.8	41.9	42.9	45.0	46.1	47.1	48.2
45	40.7	41.8	42.8	43.9	46.0	47.1	48.2	49.3

Plane-table traversing.—It is sometimes impossible to furnish the field party with a base map of proper accuracy. In all such cases the party will be supplied with a plane-table outfit, and a traverse base map of the area is to be constructed in the field by the soil-

survey party. This traverse work should, however, be reduced to a minimum.

In carrying on traverse work or surveying of any description, the methods used, where possible, should conform to well-established methods, such as are given in Wilson's Topographic Surveying.

In order to orient plane-table maps to true north and south, the map on page 4, showing the lines of equal magnetic declination, is given. The solid lines show equal declination and the dotted lines show equal annual change. The lines are moving westward, so that where the declination is east it decreases and where west it increases annually.

Samples for laboratory examination.—To avoid unnecessary work and to prevent overcrowding of the laboratory force, it will be very necessary to use care and judgment in the selection of samples for mechanical or chemical examination.

Soil samples, as a rule, should not be collected until the party has obtained a very thorough acquaintance with the type conditions; then a description of the soil should be sent in upon Form 46. This description should be of so general a nature that it will apply to all samples collected from that soil in that district. Then, too, this type description should be made of every soil type found in the district, whether it is correlated with a soil occurring in other districts or is a new type.

After this general description has been sent in a limited number of samples from not exceeding four places in each soil type, and limited to one or two localities in the case of less important types, should be collected and the individual samples described on Form 47, one card being used for each sample, whether it is of a soil or subsoil, and each sample being designated by the local name adopted for the type to which it belongs.

It will be better to defer taking samples until the work has progressed sufficiently far to insure a thoroughly representative set of samples.

A separate card (Form 48) is provided for miscellaneous samples, such as marl, minerals, crusts, and plants, and in all cases such samples should be fully described, and the kind and purpose of the examination desired should be clearly stated. Often a qualitative examination will answer if we know the purpose of the

work, and thus the long and tedious process of a complete chemical analysis may often be avoided.

Care in attending to these details will insure the greatest accuracy and the earliest completion of the work, so that the results may be available as soon as possible, preferably before the party leaves the district.

Write all cards and tags on samples of soil in ink, as pencil rubs badly and is sometimes illegible when received in the office.

Correspondence and weekly report.—All correspondence with the Bureau should be addressed to the Chief of the Bureau. At least once each week the head of the party should report to the Chief by letter, informing him of the progress of the work, the results which have been attained, describing new types of soil, and giving a statement of the health of members of the party.

At the end of each week a report on card, Form 49, should be filled out and returned to this office. This card report is not to take the place of a weekly letter, but should be accompanied by a letter giving in detail the operations of the party. The cards will be filed in the office for ready reference.

Field and office maps.—As fast as the soil maps are completed copies should be sent to the Chief of the Bureau to be filed. To facilitate this, two copies of the base map are to be made. One copy should be cut into sections not more than 5 by 7 inches in size. As soon as the soils have been surveyed on a section an exact copy should be made and forwarded to the office. With each section should be sent a legend and a profile of each soil type. On the completion of an area or sheet all field maps, with complete legend and profile, and all notebooks, plane-table sheets, or data collected are to be forwarded by registered mail. The *field copy* should be correct in every detail when sent to the office, as the copy that is sent to the printer is prepared from this or corrected from this, and not from the office copy. Necessary changes in the office copies previously forwarded will be made in this office from the original field copy. The *field copy* will be the official copy until the map is published. It should therefore be as distinct and as accurate as possible.

Directions for mapping alkali soils.—The intervals for the alkali maps are to represent, respectively, 0.20, 0.40, 0.60, 1, and 3 per

cent of salt in the dry soil. The maps are to be constructed in the field directly from the resistances.

Standardizations have been made in 15 areas, and a study of the curves reveals the fact that there is very little difference between them; certainly no more difference between curves from different areas than has been found by duplication of the standardization in one area. The following table shows the standardization made up from an average of these 15 curves. This table should be used in all reconnoissance work and can be used in all alkali surveys, except where it is found the curve does not give reliable results, or where unusual accuracy is required. In such cases a new curve should be made according to the instructions given.

Average standardization—Table of limiting values.

Salt in soil.	s. and ssc.	sc.	scc.	c. and hc.	Average.
Per cent.	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*
3.00	21.9	24.9	26.7	27.4	25.2
1.00	43.7	45.3	47.7	48.8	46.4
.60	65.9	68.8	71.1	73.5	69.8
.40	92.1	95.3	98.7	101.4	96.9
.20	163.6	172.5	178.7	193.4	177.1

The difference between the resistances for the various grades of soil is so small as to be within the limit of accuracy of the method, so that hereafter texture may be entirely disregarded and the figures in the last column used as the limiting values.

For convenience, where it is desired to determine the percentage of alkali from the resistance at 60° F., the table on the following page has been picked out from the average standardizations.

Table showing percentage of salt in soil.

Resistance at 60° F.	s. and ssc.	sc.	scc.	c.
	Per cent salt.	*Per cent salt.*	*Per cent salt.*	*Per cent salt.*
20	3.12	.....	.....	.....
25	2.65	2.98	3.19	3.30
30	2.18	2.43	2.65	2.79
35	1.69	1.91	2.13	2.28
40	1.18	1.40	1.63	1.77
45	.95	1.02	1.18	1.28
50	.83	.89	.94	.97
55	.74	.80	.84	.87
60	.67	.71	.74	.78
65	.60	.64	.67	.71
70	.55	.58	.61	.65
75	.51	.54	.56	.59
80	.47	.51	.52	.54
85	.44	.47	.49	.50
90	.41	.43	.45	.47
95	.38	.40	.42	.44
100	.36	.37	.39	.41
105	.34	.35	.37	.38
110	.32	.33	.35	.36
115	.30	.31	.33	.34
120	.29	.30	.31	.33
125	.27	.28	.30	.31
130	.25	.27	.28	.30
135	.24	.26	.27	.29
140	.23	.25	.26	.28
145	.22	.24	.25	.26
150	.21	.23	.24	.25
155	.21	.22	.23	.24
160	.20	.21	.22	.23
165	.20	.21	.22	.23
170	.19	.20	.21	.22

If more accurate work is to be done, or it is believed the above limits do not fit the conditions, the work is to be standardized in each district in the following way: Take eight or ten crusts, including the top inch of soil, or if crusts can not be obtained, take the

strongest alkali soils from different places over the whole area. Fill a large cup, tumbler, or bottle about one-third full with a crust or soil, using more or less, according to the richness of the material, and nearly fill the receptacle with distilled water. Stir or shake vigorously several times and filter off a pint of the solution, using the filter pump. Rinse out the filter pump after each sample. Treat the eight or ten crusts or soils in the same way. The presence of black alkali will frequently give the solutions a reddish color, but this can be ignored. Determine the electrical resistances of the solutions in the cell. Take an amount of the strongest solution equivalent to approximately 200 cc. having a resistance of about 5 ohms, and add to it a volume of each of the others proportional to the resistances determined. If the resistance of this mixture, containing approximately equal quantities of salts from the eight or ten localities, is 10 ohms or less, it can be used directly for the standardization. If the resistance is greater than 10 ohms, the solution should be evaporated until the resistance is sufficiently low. Carefully measure out 100 cc. of this composite solution and transfer it to a small dish which has been carefully cleaned, dried, and accurately weighed to centigrams. Evaporate to dryness, ignite very gently to free the sulphates and carbonates of water of crystallization, let cool, and again weigh. The gain in weight will give the percentage in salts in the composite solution. This percentage divided into any percentage in the following table multiplied by 100 will give the number of cubic centimeters of the composite solution required to be diluted to 100 cc. in order to obtain the corresponding percentage in first column of the table. If the volume thus secured for some of the higher concentrations exceeds 100 cc., it should be reduced to 100 cc. by evaporation. Ordinarily a $3\frac{1}{3}$ per cent solution is as concentrated as will be required, as this represents 1 per cent of salt in the soil. The electrical resistance of this $3\frac{1}{3}$ per cent solution in any cell, divided by 0.24, will equal the resistance of sand or sandy loam in the same cell when completely saturated and at a temperature of 60° F., when the soil contains 1 per cent of salt. The composite solution is to be diluted and the resistance determined at the various concentrations, corresponding to the limiting values of the alkali map for four grades of soil.

The dilutions are as follows, the figures representing the percentage concentration to which the solution is to be reduced:

To obtain limiting values.

Salt in soil.	Salt in solution.			
	s. and ssc.	sc.	scc.	c. and hc.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3.00	10.00	7.95	7.14	6.67
1.00	3.33	2.65	2.38	2.22
.60	2.00	1.59	1.43	1.33
.40	1.33	1.06	.95	.89
.20	.67	.53	.48	.44
Resistances to be reduced to 60° F. and divided by	.24	.275	.29	.30

NOTE.—S. and ssc., sand and sandy loam; sc., loam; scc., clay loam; c. and hc., clay and heavy clay soil.

The result will give the cell resistance, when filled with saturated soil, at 60° F., corresponding to the limiting values to be inserted in the following table:

Table of limiting values.

Salt in soil.	s. and ssc.	sc.	scc.	c. and hc.
Per cent.	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*
3.00				
1.00				
.60				
.40				
.20				

NOTE.—If it is desirable to determine the 3 per cent limit in the soil, portions of the composite solution will have to be concentrated by evaporation according to the above directions so as to contain the percentage of salt given in the table. The cell filled with such concentrated solutions gives a resistance too low to be read on the instrument, and it will be necessary to take a measured amount of the solution in the cell, as for example, one-fourth or one-fifth its capacity. Determine the resistance and divide it by 4 or 5, as the case may be. This gives the resistance of the cell when filled. For these concentrated solutions the readings will be rather indefinite. Keep the cell electrodes well cleaned at all times.

The irrigation water, or the soil, the electrical resistance of which is to be found, is put into the hard-rubber cell with metal electrodes. If the salt content of water is to be determined, the cell is filled even full with the water. If the salt content of soils is to be determined, the soil is made into the condition of a thin mortar with distilled water and the cell filled with this material, gently tapping the cell on the ground to exclude air bubbles. The top of the soil is then struck off with a knife edge, so that the cell shall be just level full of the saturated soil. The cell is then suspended in the mercury cups attached to the electrolytic bridge and the electrical resistance determined in the following way:

The telephone receiver is pressed against the ear and the handle of the instrument pressed down, when a buzzing sound will be heard in the receiver. Holding the handle down so as to keep the battery switch closed, the pointer is rotated to either right or left until the position is found at which the note in the telephone receiver is no longer heard or is only indistinctly heard. On rotating the pointer to either side of this position, the sound in the receiver should gradually increase. In case difficulty is found in locating the exact position of balance, it will be found of assistance to rotate the pointer rapidly back and forth over the position of least sound, locating points of equal intensity on either side. The mean position between these two points gives the position of balance, and the number opposite the pointer gives the desired reading.

In case a balance is not obtained with the 1,000-ohm coil of the rotary switch, the 100-ohm and 10-ohm coils should be tried in succession. It is best to choose the coil which will bring the balance as near as possible to the center of the scale, as this is the most sensitive position.

Having obtained the balance, the resistance is found by multiplying the resistance of the comparison coil, as shown by the rotating switch, by the number on the scale opposite the pointer. Thus, if the comparison coil used has a resistance of 100 ohms and the reading on the scale is 0.92, the resistance in the scale is 92 ohms. If the comparison coil is 1,000 ohms and the reading on the scale is 4.5, the resistance would be 4,500 ohms. After taking the resistance in this manner, take the temperature immediately,

either of the water or of the saturated soil, by sticking the bulb of a thermometer in and leaving it for some moments. The resistance is then corrected for this temperature according to the directions given below.

Reduction of resistances to a temperature of 60° F.—A single illustration will serve to show the way the following table is used in the reduction of electrical resistances to a uniform temperature of 60° F.: Suppose the observed resistance of the soil is 2,585 ohms at a temperature of 50.5°. In the table, at the temperature of 50.5°, as indicated on the left-hand side, we find that at that temperature 2,000 ohms is equal to 1,748 ohms at 60°; 5,000 ohms is equal to 4,370 ohms at 60°; hence 500 ohms would be equal to 437 ohms. Similarly, 80 ohms would be one-hundredth of the value given for 8,000 ohms at 50.5° in the table, therefore equal to about 70 ohms at 60°, while the 5 ohms would be equal to about 4 ohms. These separate values are added together thus:

2,000	1,748
500	437
80	70
5	4
2,585 ohms at 50.5°	2,259 ohms at 60°.

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.

°F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
32.0	625	1,250	1,875	2,500	3,125	3,750	4,375	5,000	5,625
32.5	632	1,264	1,896	2,528	3,150	3,792	4,424	5,056	5,688
33.0	639	1,278	1,917	2,556	3,195	3,834	4,473	5,112	5,751
33.5	646	1,292	1,938	2,584	3,230	3,876	4,522	5,168	5,814
34.0	653	1,306	1,959	2,612	3,265	3,918	4,571	5,224	5,877
34.5	660	1,320	1,980	2,640	3,300	3,960	4,620	5,280	5,940
35.0	667	1,334	2,001	2,668	3,335	4,002	4,669	5,336	6,003
35.5	674	1,348	2,022	2,696	3,370	4,044	4,718	5,392	6,066
36.0	681	1,362	2,043	2,724	3,405	4,086	4,767	5,448	6,129
36.5	688	1,376	2,064	2,752	3,440	4,128	4,816	5,504	6,192
37.0	695	1,390	2,085	2,780	3,475	4,170	4,865	5,560	6,255
37.5	702	1,404	2,106	2,808	3,510	4,212	4,914	5,616	6,318
38.0	709	1,418	2,127	2,836	3,545	4,254	4,963	5,672	6,381
38.5	716	1,432	2,148	2,864	3,580	4,296	5,012	5,728	6,444
39.0	722	1,444	2,166	2,888	3,610	4,332	5,054	5,776	6,498
39.5	729	1,458	2,187	2,916	3,645	4,374	5,103	5,832	6,561
40.0	736	1,472	2,208	2,944	3,680	4,416	5,152	5,888	6,634
40.5	743	1,486	2,229	2,972	3,715	4,458	5,201	5,944	6,687
41.0	750	1,500	2,250	3,000	3,750	4,500	5,250	6,000	6,750
41.5	757	1,514	2,271	3,028	3,785	4,542	5,299	6,056	6,813
42.0	763	1,526	2,289	3,052	3,815	4,578	5,341	6,104	6,867
42.5	770	1,540	2,310	3,080	3,850	4,620	5,390	6,160	6,930
43.0	776	1,552	2,328	3,104	3,880	4,656	5,432	6,208	6,984
43.5	782	1,564	2,346	3,128	3,910	4,692	5,474	6,256	7,038
44.0	788	1,576	2,364	3,152	3,940	4,728	5,516	6,304	7,092
44.5	794	1,588	2,382	3,176	3,970	4,764	5,558	6,352	7,146
45.0	800	1,600	2,400	3,200	4,000	4,800	5,600	6,400	7,200
45.5	807	1,614	2,421	3,228	4,035	4,842	5,649	6,456	7,263
46.0	814	1,628	2,442	3,256	4,070	4,884	5,698	6,512	7,326
46.5	821	1,642	2,463	3,284	4,105	4,926	5,747	6,568	7,389
47.0	828	1,656	2,484	3,312	4,140	4,968	5,796	6,624	7,452
47.5	835	1,670	2,505	3,340	4,175	5,010	5,845	6,680	7,515
48.0	842	1,684	2,526	3,368	4,210	5,052	5,884	6,736	7,578
48.5	849	1,698	2,547	3,396	4,245	5,094	5,933	6,792	7,641
49.0	856	1,712	2,568	3,424	4,280	5,136	5,992	6,848	7,704
49.5	862	1,724	2,586	3,448	4,310	5,172	6,034	6,896	7,758
50.0	868	1,736	2,604	3,472	4,340	5,208	6,076	6,944	7,812
50.5	875	1,750	2,625	3,500	4,375	5,250	6,125	7,000	7,875
51.0	881	1,762	2,643	3,524	4,405	5,286	6,167	7,048	7,929
51.5	887	1,774	2,661	3,548	4,435	5,322	6,209	7,096	7,983
52.0	893	1,786	2,679	3,572	4,465	5,358	6,251	7,144	8,037
52.5	900	1,800	2,700	3,600	4,500	5,400	6,300	7,200	8,100
53.0	906	1,812	2,718	3,624	4,530	5,436	6,342	7,248	8,154
53.5	912	1,824	2,736	3,648	4,560	5,472	6,384	7,296	8,208
54.0	919	1,838	2,757	3,676	4,595	5,514	6,433	7,352	8,271
54.5	926	1,852	2,778	3,704	4,630	5,556	6,482	7,408	8,334

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.—Continued.

°F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
55.0	933	1,866	2,799	3,732	4,665	5,598	6,531	7,464	8,397
55.5	940	1,880	2,820	3,760	4,700	5,640	6,580	7,526	8,460
56.0	947	1,894	2,841	3,780	4,735	5,682	6,629	7,576	8,523
56.5	954	1,908	2,862	3,816	4,770	5,724	6,678	7,632	8,586
57.0	961	1,922	2,883	3,841	4,805	5,766	6,727	7,688	8,649
57.5	968	1,936	2,904	3,872	4,839	5,807	6,775	7,743	8,711
58.0	974	1,948	2,922	3,896	4,870	5,844	6,818	7,792	8,766
58.5	981	1,962	2,943	3,924	4,905	5,886	6,867	7,848	8,829
59.0	987	1,974	2,962	3,949	4,936	5,923	6,910	7,898	8,885
59.5	994	1,988	2,982	3,976	4,971	5,935	6,959	7,953	8,947
60.0	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000
60.5	1,006	2,012	3,018	4,024	5,030	6,036	7,042	8,048	9,054
61.0	1,013	2,026	3,039	4,052	5,065	6,078	7,091	8,104	9,117
61.5	1,020	2,040	3,060	4,080	5,100	6,120	7,140	8,160	9,180
62.0	1,027	2,054	3,081	4,108	5,135	6,162	7,189	8,216	9,243
62.5	1,033	2,066	3,099	4,132	5,165	6,198	7,231	8,264	9,297
63.0	1,040	2,080	3,120	4,160	5,200	6,240	7,280	8,320	9,360
63.5	1,047	2,094	3,141	4,188	5,235	6,282	7,329	8,376	9,423
64.0	1,054	2,108	3,162	4,216	5,270	6,324	7,378	8,432	9,486
64.5	1,061	2,122	3,183	4,244	5,305	6,366	7,427	8,488	9,549
65.0	1,068	2,136	3,204	4,272	5,340	6,408	7,476	8,544	9,612
65.5	1,075	2,150	3,225	4,300	5,375	6,450	7,525	8,600	9,675
66.0	1,082	2,164	3,246	4,328	5,410	6,492	7,574	8,656	9,738
66.5	1,089	2,178	3,267	4,356	5,445	6,534	7,623	8,712	9,801
67.0	1,096	2,192	3,288	4,384	5,480	6,576	7,672	8,768	9,864
67.5	1,103	2,206	3,309	4,412	5,515	6,618	7,721	8,824	9,927
68.0	1,110	2,220	3,330	4,440	5,550	6,660	7,770	8,880	9,990
68.5	1,117	2,234	3,351	4,468	5,585	6,702	7,819	8,936	10,053
69.0	1,125	2,250	3,375	4,500	5,625	6,750	7,875	9,000	10,125
69.5	1,133	2,266	3,399	4,532	5,665	6,798	7,931	9,064	10,197
70.0	1,140	2,280	3,420	4,560	5,700	6,840	7,980	9,120	10,260
70.5	1,147	2,294	3,441	4,588	5,735	6,882	8,029	9,176	10,323
71.0	1,155	2,310	3,465	4,620	5,775	6,930	8,085	9,240	10,395
71.5	1,162	2,324	3,486	4,648	5,810	6,972	8,134	9,296	10,458
72.0	1,170	2,340	3,510	4,680	5,850	7,028	8,190	9,369	10,530
72.5	1,177	2,354	3,531	4,708	5,885	7,062	8,239	9,416	10,593
73.0	1,185	2,370	3,555	4,740	5,925	7,110	8,295	9,480	10,665
73.5	1,193	2,386	3,579	4,772	5,965	7,158	8,351	9,544	10,737
74.0	1,201	2,402	3,603	4,804	6,005	7,206	8,407	9,608	10,809
74.5	1,208	2,416	3,624	4,832	6,040	7,248	8,456	9,664	10,872
75.0	1,215	2,430	3,645	4,860	6,075	7,290	8,505	9,720	10,935
75.5	1,222	2,444	3,666	4,888	6,110	7,332	8,554	9,776	10,998
76.0	1,230	2,460	3,690	4,920	6,158	7,380	8,610	9,840	11,070
76.5	1,238	2,476	3,714	4,952	6,190	7,428	8,666	9,904	11,142
77.0	1,246	2,492	3,738	4,984	6,230	7,476	8,722	9,968	11,214
77.5	1,254	2,508	3,762	5,016	6,270	7,524	8,778	10,032	11,286

Reduction of the electrical resistance of soils to a uniform temperature of 60° F.—Continued.

°F.	1000	2000	3000	4000	5000	6000	7000	8000	9000
78.0	1,262	2,524	3,786	5,048	6,310	7,572	8,834	10,096	11,358
78.5	1,270	2,540	3,810	5,080	6,350	7,620	8,890	10,160	11,430
79.0	1,278	2,556	3,834	5,112	6,390	7,668	8,946	10,224	11,502
79.5	1,286	2,572	3,858	5,144	6,430	7,716	9,002	10,288	11,574
80.0	1,294	2,588	3,882	5,176	6,470	7,754	9,058	10,352	11,646
80.5	1,302	2,604	3,906	5,208	6,510	7,812	9,114	10,416	11,718
81.0	1,310	2,620	3,930	5,240	6,550	7,860	9,170	10,480	11,790
81.5	1,318	2,636	3,954	5,272	6,590	7,908	9,226	10,544	11,862
82.0	1,327	2,654	3,981	5,308	6,635	7,962	9,289	10,616	11,943
82.5	1,335	2,670	4,005	5,340	6,675	8,010	9,345	10,680	12,015
83.0	1,343	2,686	4,029	5,372	6,715	8,058	9,401	10,744	12,087
83.5	1,351	2,702	4,053	5,404	6,755	8,106	9,457	10,808	12,159
84.0	1,359	2,718	4,077	5,436	6,795	8,154	9,513	10,872	12,231
84.5	1,367	2,734	4,101	5,468	6,835	8,202	9,569	10,936	12,303
85.0	1,376	2,752	4,128	5,504	6,880	8,256	9,632	11,008	12,384
85.5	1,385	2,770	4,155	5,540	6,925	8,310	9,695	11,080	12,465
86.0	1,393	2,786	4,179	5,572	6,965	8,358	9,751	11,144	12,537
86.5	1,401	2,802	4,203	5,604	7,005	8,406	9,807	11,208	12,609
87.0	1,409	2,818	4,227	5,636	7,045	8,454	9,863	11,272	12,681
87.5	1,418	2,836	4,254	5,672	7,090	8,508	9,931	11,344	12,762
88.0	1,427	2,854	4,281	5,708	7,135	8,562	9,989	11,416	12,843
88.5	1,435	2,870	4,305	5,740	7,175	8,610	10,040	11,480	12,915
89.0	1,443	2,886	4,329	5,772	7,215	8,658	10,091	11,544	12,987
89.5	1,451	2,902	4,353	5,804	7,255	8,706	10,157	11,608	13,059
90.0	1,460	2,920	4,380	5,840	7,300	8,760	10,220	11,680	13,140
90.5	1,468	2,936	4,404	5,872	7,340	8,808	10,276	11,744	13,212
91.0	1,477	2,954	4,431	5,908	7,385	8,862	10,339	11,816	13,293
91.5	1,486	2,972	4,458	5,944	7,430	8,916	10,402	11,888	13,374
92.0	1,495	2,990	4,485	5,980	7,475	8,970	10,465	11,960	13,455
92.5	1,504	3,008	4,512	6,016	7,520	9,024	10,528	12,032	13,536
93.0	1,513	3,026	4,539	6,052	7,565	9,078	10,591	12,104	13,617
93.5	1,522	3,044	4,566	6,088	7,610	9,132	10,654	12,176	13,698
94.0	1,531	3,062	4,593	6,124	7,655	9,186	10,717	12,248	13,779
94.5	1,540	3,080	4,620	6,160	7,700	9,240	10,780	12,320	13,860
95.0	1,549	3,098	4,647	6,196	7,745	9,294	10,843	12,392	13,941
95.5	1,559	3,118	4,677	6,236	7,795	9,354	10,913	12,472	14,031
96.0	1,569	3,138	4,707	6,276	7,845	9,414	10,983	12,552	14,121
96.5	1,579	3,158	4,737	6,316	7,895	9,474	11,053	12,632	14,211
97.0	1,589	3,178	4,767	6,356	7,945	9,534	11,123	12,712	14,301
97.5	1,599	3,198	4,797	6,396	7,995	9,594	11,193	12,792	14,391
98.0	1,609	3,218	4,827	6,436	8,045	9,654	11,263	12,872	14,481
98.5	1,619	3,238	4,857	6,476	8,095	9,714	11,333	12,952	14,571
99.0	1,629	3,258	4,887	6,516	8,145	9,774	11,403	13,032	14,661

Directions for estimating soluble salts in soils.—Take a known volume (or weight) of saturated soil, wash into a 250 cc. flask and fill to the mark with distilled water, and filter if necessary. Take 50 cc. of the solution and titrate with N/20 acid potassium sulphate, containing 6.758 grams per liter, using phenolpthalein as an indicator. This will represent the carbonates. Then add a drop or so of methyl orange or congo red and again titrate with N/20 acid potassium sulphate. Subtract an amount equal to the first titration from the second, and the difference represents the bicarbonates. Add a few drops of potassium chromate as an indicator to the same solution and titrate with N/10 silver nitrate. This will represent the chlorides. The salts are all to be estimated as sodium salts, as follows:

1 cc. N/20 $HKSO_4$ is equivalent to 0.005266 gram Na_2CO_3.
1 cc. N/20 $HKSO_4$ is equivalent to 0.004172 gram $NaHCO_3$.
1 cc. N/10 $AgNO_3$ is equivalent to 0.005806 gram NaCl.

In areas where the amount and distribution of sodium carbonate warrant it, construct the sodium carbonate map in the field from the volume of solution used. Limiting values will be 0.3, 0.2, 0.1, and 0.05 per cent of dry soil. The limiting values for each vessel are found in the following way: Multiply the volume of saturated soil, represented by the solution taken for titration, by the numbers in the following table:

Na_2CO_3 in soil.	s. and ssc.	sc.	scc.	c. and hc.
Per cent.				
0.30	0.832	0.752	0.720	0.689
.20	.554	.502	.480	.459
.10	.277	.251	.240	.230
.05	.138	.125	.120	.115

These results so obtained are the cubic centimeters of N/10 solution of sodium carbonate corresponding to the limiting values, to be inserted in the following table:

Na_2CO_3 in soil.	s. and ssc.	sc.	scc.	c. and hc.
Per cent.	*cc.*	*cc.*	*cc.*	*cc.*
0.30	.....	.....	.....	.....
.20	.....	.....	.....	.....
.10	.....	.....	.....	.....
.05	.....	.....	.....	.....

If it is desired to reduce the volume of N/10 $AgNO_3$ to per cent of NaCl in dry soil, the following formula may be used:

$$\frac{V\ 0.005806}{V'\ K}$$

Substituting 0.004172 for 0.005806, the same formula may be used to reduce the volume of N/20 $HKSO_4$ to per cent of $NaHCO_3$. V=cubic centimeters N/10 $AgNO_3$ or N/20 $HKSO_4$ solution used; V′=volume saturated soil represented in amount of solution titrated; K=constant for type of soil as follows:

s. and ssc.=1.46; sc.=1.32; scc.=1.26; c. and hc.=1.21.

Construction of alkali maps.—The directions for mapping alkali soils in the field, just given, which are also to be found in the front of the Alkali Field Book, will enable you to determine the percentage of alkali in any sample of soil. It has been the practice of this Bureau to prepare maps showing the percentage of alkali in the surface 6 feet of soil. This has generally been considered to be a mathematical average of the salt content of the 6 feet; but in nearly all cases the judgment of the person in charge of the work as to the actual crop value of the soil on the basis of alfalfa has entered into the construction of the maps.

To do away as much as possible with this element of judgment and to place the construction of the maps entirely upon a percentage basis—that they may be of equal value when any crop is considered—and to permit the strict comparison of the work done by different men, the following plan is to be adopted:

The percentage of alkali salts in each foot of land to a depth of

6 feet will be determined according to the directions in the front of the Alkali Field Book. In many cases, after the observer becomes familiar with the soils of a locality, the field work may be very much shortened by making the alkali determinations in alternate foot sections or by mixing 2 or more feet for one salt determination.

The percentage of alkali, as indicated by the various colors upon the alkali map, is to be a mathematical average of the alkali in the foot sections. In case there should be a marked accumulation of the alkali at any one part of the vertical section, such as the surface of the ground or in an alkali hardpan, the judgment of the observer is to decide whether the strict mathematical average should be followed or whether the soil is to be mapped as of the next higher grade of alkali content. If these areas, where there is a zone of accumulation of the alkali such as an accumulation at the surface, are of considerable extent, they are to be indicated upon the field map by special rulings in lead pencil, and when the field maps are published, the rulings will be described in the legend of the map. Thus, if a soil contain on an average 0.2 per cent of alkali, but has an accumulation of 0.5 per cent of alkali on the surface, this soil should be colored to show 0.2 per cent alkali, and the fact that there is a surface accumulation should be indicated by black rulings across the area affected. If the accumulation is below the surface foot another kind of ruling can be used to indicate that fact. Appropriate lettering upon the maps will render these rulings intelligible.

Determination of salts in water.—Fill the electrolytic cell with water and take the resistance. Take the temperature with an ordinary thermometer, and reduce to 60° F. by use of the tables on pages 33, 34, and 35. The salt content corresponding to this resistance may be found from the following table, compiled by Mr. Seidell from a large number of laboratory determinations. The curve varies with the character of salts present. Where no carbonates are present in the water, the figures in the column marked "Chlorides" should be used. Where the percentage of carbonates is high (more than 50 per cent from a preliminary estimate of the total salt content), the figures in the column marked "Carbonates" should be used. For intermediate percentages of carbonates a corresponding intermediate value between those given in the two columns should be used.

Table for determining total salt content of water from resistance at 60° F.

Resistance 60° F.	Chlorides.	Carbonates.	Resistance 60° F.	Chlorides.	Carbonates.	Resistance 60° F.	Chlorides.	Carbonates.
30	750		140	141	200	340	50	71
35	670		150	132	187	360	47	65
40	595		160	124	176	380	44	60
45	525		170	116	165	400	41	55
50	460	460	180	109	154	450	35	46
55	400	425	190	102	144	500	31	38
60	355	395	200	96	138	550	28	32
65	305	375	210	91	130	600	25	27
70	265	355	220	87	122	700	22	23
75	230	335	230	83	116	800	20	
80	213	320	240	79	110	900	19	
85	203	306	250	75	105	1,000	18	
90	195	294	260	71	100	1,200	17	
95	188	284	270	68	95	1,400	16	
100	181	262	280	65	90	1,600	16	
110	170	250	290	62	86	1,800	15	
120	160	231	300	59	83	2,000	15	
130	150	213	320	54	77	.....	.....	

When samples of water are examined in the field by the chemical methods described on the preceding page, the following table will assist in the calculation of parts per 100,000 of Na_2CO_3, $NaHCO_3$, and NaCl. Fifty cubic centimeters of water should be used in making the titrations.

Cc. N/20 $KHSO_4$ or N/20 $AgNO_3$.	Parts per 100,000 of water.		
	Na_2CO_3.	$NaHCO_3$.	NaCl.
1.....	10.53	8.34	11.61
2.....	21.06	16.69	23.22
3.....	31.60	25.03	34.84
4.....	42.13	33.38	46.45
5.....	52.66	41.72	58.06
6.....	63.19	50.06	69.67
7.....	73.72	58.41	81.28
8.....	84.26	66.75	92.89
9.....	94.79	75.10	104.51

The electrolytic cells are made as nearly of the same dimensions as possible, but if there is much variation in either volume or shape this table must not be used without a correction for the cell.

If greater accuracy is desired than can be expected by the use of the above table, proceed in the following way:

Collect 6 or 8 samples of water from different parts of the area; determine the electrical resistance of each, and take an amount of each proportional to the resistance, mixing them in a clean vessel. There should be at least 2 quarts, and preferably 1 gallon, of this mixture. Evaporate slowly on a stove until the mixture is about as strong as the strongest water likely to be encountered. If there is any possibility of encountering water as strong as a 1 per cent solution—that is, 1,000 parts of salts in 100,000 parts of water—the mixture should be evaporated until it gives a resistance in the cell of about 23 ohms. The amount of this evaporation can be determined by the original resistance of the mixture. If the resistance of the mixture is 100 ohms, it should be evaporated to one-fourth its volume to make approximately a 1 per cent solution. If the resistance is 400 ohms, the solution should be evaporated to one twenty-third of its original volume. Water having a resistance of 400 ohms would have a salt content, according to the above table, of about 44 in 100,000, and would be considered an excellent water for irrigation purposes. It would require 3 gallons of such water, evaporated to 1 pint, to make a 1 per cent solution.

To determine the actual per cent of salt in this solution, after finding the resistance in a cell, evaporate in a weighed vessel—such as a tin cup or a tin can—a separate, weighed amount of the water. Weigh the vessel again after the evaporation, and this will give the amount of residue in a known weight of water. The weighing should be carefuly done on reliable druggists' scales.

Take the concentrated solution and dilute with successive quantities of distilled water, so as to change the concentration of the solution and get the corresponding resistances in the cell. Use, for example, 9 parts of the solution and 1 part distilled water, then 8 parts of the solution and 2 parts of distilled water, and so on down to any dilution likely to be encountered. This will give the resistance corresponding very exactly with known amounts of salt, and will furnish a table for the estimation of the salt content from the resistance of any water in the area.

The table constructed from this data can be used directly by interpolation, or preferably a curve should be constructed and any intermediate points picked out from this.

Form of a soil survey report.—Owing to the large amount of data being collected by the soil-survey parties, it will be necessary to confine the report from each party to about 50 typewritten pages of 250 words each, or 25 printed pages of 500 words each for the Western Division and to about 15 or 20 printed pages for the Eastern Division. The material for the report should be collected and written up, so far as possible, before the party leaves the field.

An outline of the chapters is given as a guide in the arrangement of the report, and should be followed as closely as circumstances will permit. The number of words to be given in each chapter will be a guide in the preparation of the material and is given as the result of experience in former reports. It is understood of course that the headings will necessarily have to be changed somewhat in different districts, and the relative importance of the different chapters will vary with the locality. This is intended, therefore, simply as a guide in the preparation of the reports, and the number of words should be taken as the maximum to be used except in the case of matters of special importance, which may need fuller treatment.

The matter should be presented in a terse style, and no more words used than are absolutely necessary to convey the meaning, being careful, however, to treat each subject so that all important phases may be brought out and clearly stated. In order to attain this, the different chapters should be revised several times if necessary, so that all important matters may be considered and all unnecessary words eliminated. A careful consideration of this matter of style in writing is enjoined upon all members of the division charged with the preparation of reports.

Outline of soil survey report.—The outline of chapters referred to is as follows:

I. Location and Boundaries of the Area (100 words).
II. History of Settlement and Agricultural Development (500 words).
    Date or dates of county organization.
    Principal source of population.
    Agricultural development.
III. Climate.

IV. Physiography and Geology (500 words).[a]

V. Soils (500 words to each type).[b]

- Name, description, depth, and color of soil and subsoil.[c]
- Location of soil in area.
- Topographic features.
- Drainage features.
- Origin of soil and processes of formation.
- Mineral or chemical features. Alkali salts.
- Unusual or characteristic crops to which adapted.
- Crops grown and average yields.

VI. Special Soil Problems, such as Hardpan, Acid Soils, Reclamation of Swamp and Worn-out lands (100 words).

VII. Water Supply for Irrigation, Amount and Character (250 words).

VIII. Underground and Seepage Waters, Drainage of Soils (250 words).

IX. Alkali in Soils (1,000 words).[b]

- Location of alkali areas.
- Origin of alkali.
- Chemical composition of alkali.
- Distribution in soil.
- Reclamation of alkali lands.

X. Agricultural Methods in Use as Adapted to the Soils and Conditions of the Area.

XI. Agricultural Conditions in the Area (1,500 words).[b]

- General prosperity of farming class.
- Tenure of farms.
- General size of farms.
- Character of labor.
- Character of principal products.
- Recognition of adaptation of soils to crops.
- Transportation facilities.
- Markets.

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[a] The physiography should be described in some detail; the geology should be briefly treated, only those features having a direct or important bearing on the soils being considered. Authorities for statements made should be cited whenever possible.

[b] In preparing Chapters V, IX, and XI write in the subtopics and discuss each in the order given. This will aid in securing uniformity in the reports, and prevent the omission of matter important in making comparisons of the soils and conditions in different areas.

[c] The greatest care should be taken to make the descriptions of the soils, while full enough to be clear, concise and explicit.

REFERENCES TO SOIL SURVEY REPORTS.

Following the description of the type is a list of locations in which the soil has been mapped. For convenience in referring to the original description of the soil, an alphabetical list of all areas surveyed by the Bureau is here given, with a reference showing the number of the volume and the page where the description occurs. The volume reference is to the different reports of Field Operations, Bureau of Soils.

Abbeville, S. C., 4, p. 273.
Acadia, La., 5, p. —.
Alamance County, N. C., 3, p. 297.
Albemarle, Va., 4, p. 187.
Allegan County, Mich., 3, p. 93.
Arecibo to Ponce, P. R., 4, p. 793.
Asheville, N. C., 5, p. —.
Ashtabula, Ohio, 5, p. —.

Baker City, Oreg., 5, p. —.
Bedford, Va., 3, p. 239.
Bigflats, N. Y., 4, p. 125.
Billings, Mont., 4, p. 665.
Blackfoot, Idaho, 5, p. —.
Boise, Idaho, 3, p. 421.
Brazoria, Tex., 4, p. 349.
Brookings, S. Dak., 5, p. —.

Calvert County, Md., 2, p. 147.
Campobello, S. C., 5, p. —.
Cary, N. C., 3, p. 311.
Cecil County, Md., 2, p. 103.
Cerro Gordo County, Iowa, 5, p. —.
Clay County, Ill., 4, p. 507.
Clinton County, Ill., 4, p. 491.
Cobb County, Ga., 3, p. 317.
Columbus, Ohio, 4, p. 403.
Connecticut Valley, Conn.-Mass., 5, p. —.
Covington, Ga., 3, p. 329.
Craven, N. C., 5, p. —.

Darlington, S. C., 4, p. 291.
Davidson County, Tenn., 5, p. —.
Dover, Del., 5, p. —.
Dubuque, Iowa, 4, p. 571.

Fargo, N. Dak., 5, p. —.
Fort Payne, Ala., 5, p. —.
Fort Valley, Ga., 5, p. —.
Fresno, Cal., 2, p. 333.

Gadsden County, Fla., 5, p. —.
Grand Forks, N. Dak., 4, p. 643.
Grand Island, Nebr., 5, p. —.

Hanford, Cal., 3, p. 447.
Harford County, Md., 3, p. 211.
Hickory, N. C., 4, p. 239.
Howell County, Mo., 4, p. 593.
Huntsville, Ala., 5, p. —.

Imperial, Cal., 5, p. —.
Indio, Cal., 5, p. —.

Jacksonville, Tex., 5, p. —.
Jamestown, N. Dak., 5, p. —.
Janesville, Wis., 4, p. 549.
Johnson County, Ill., 5, p. —.

Kent County, Md., 2, p. 173.
Knox County, Ill., 5, p. —.

Lancaster County, Pa., 2, p. 61.
Lake Charles, La., 3, p. 621.
Laramie, Wyo., 5, p. —.
Lebanon, Pa., 3, p. 149.
Leesburg, Va., 5, p. —.
Lewiston, Idaho, 4, p. 689.
Lockhaven, Pa., 5, p. —.
Long Island, N. Y., 5, p. —.
Los Angeles, Cal., 5, p. —.
Lower Arkansas Valley, Colo., 4, p. 729.
Lufkin, Tex., 5, p. —.
Lyons, N. Y., 4, p. 143.

McLean County, Ill., 5, p. —.
McNeill, Miss., 5, p. —.
Madison County, Ind., 5, p. —.
Marshall, Minn., 5, p. —.
Mason County, Ky., 5, p. —.
Miller County, Ark., 5, p. —.
Mobile, Ala., 5, p. —.
Mount Mitchell, N. C., 4, p. 259.
Montgomery County, Ohio, 2, p. 85.
Montgomery County, Tenn., 3, p. 341.

Nacogdoches, Tex., 5, p. —.
New Orleans, La., 5, p. —.
Norfolk, Va., 5, p. —.

Ouachita, La., 5, p. —.

Paris, Tex., 5, p. —.
Parsons, Kans., 5, p. —.
Pecos Valley, N. Mex., 1, p. 36.
Perry County, Ala., 4, p. 309.
Pikeville, Tenn., 5, p. —.
Pontiac, Mich., 5, p. —.
Posey County, Ind., 4, p. 441.
Prince Edward, Va., 3, p. 259.
Prince George County, Md., 3, p. 173.
Provo, Utah, 5, p. —.

Raleigh to Newbern, N. C., 2, p. 187.
Russell, Kans., 5, p. —.

St. Clair County, Ill., 4, p. 507.
St. Mary County, Md., 2, p. 125.
Salem, N. J., 3, p. 125.
Salem, Oreg., 5, p. —.
Salinas Valley, Cal., 3, p. 481.
Salt Lake Valley, Utah, 1, p. 77.
Salt River Valley, Ariz., 2, p. 287.
Sangamon County, Ill., 5, p. —.
San Gabriel, Cal., 3, p. 559.
San Jose, Cal., 5, p. —.
San Luis Valley, Colo., 5, p. —.
Santa Ana, Cal., 2, p. 385.
Scott County, Ky., 5, p. —.
Sevier Valley, Utah, 2, p. 243.
Shelby County, Mo., 5, p. —.
Smedes, Miss., 4, p. 325.
Solomonsville, Ariz., 5, p. —.
Stanton, Nebr., 5, p. —.
Statesville, N. C., 3, p. 273.
Story County, Iowa, 5, p. —.
Stuttgart, Ark., 4, p. 611.
Syracuse, N. Y., 5, p. —.

Toledo, Ohio, 4, p. 383.
Tazewell County, Ill., 4, p. 465.
Trenton, N. J., 4, p. 163.

Union County, Ky., 4, p. 425.

Ventura, Cal., 3, p. 521.
Vernon, Tex., 4, p. 365.
Viroqua, Wis., 5, p. —.

Walla Walla, Wash., 4, p. 711.
Weber County, Utah, 2, p. 207.
Westfield, N. Y., 3, p. 75.
Wichita, Kans., 4, p. 623.
Willis, Tex., 3, p. 607.
Winnebago County, Ill., 5, p. —.
Woodville, Tex., 5, p. —.
Worcester County, Md., 5, p. —.

Yazoo, Miss., 3, p. 359.
Yakima, Wash., 3, p. 389.
Yuma, Ariz., 4, p. 777.

SOIL TYPES RECOGNIZED BY THE BUREAU OF SOILS.

[For convenience in comparing soils the mechanical analyses have been recalculated and averaged and given in four grades, as follows:

1	2	3	4
Fine gravel.	Fine sand.	Silt.	Clay.
Coarse sand.	Very fine sand.		
Medium sand.			

The number in parentheses immediately following "soil" and "subsoil" indicate the number of samples from which the average has been derived.]

LOOSE INCOHERENT SANDS AND ROCK OUTCROP.

There are certain soils and rock exposures which do not readily fall into any general classification, and which by excessive local action of wind or water are liable to occur in any areas or in any group of soils and to be formed of any kind of material. They

are by reason of their texture or present physiographic position usually unproductive. These have been embraced under the following types:

Dunesand.—Consists of loose, incoherent sand of medium to fine grades to a depth of 3 feet or more, and often extending to a depth of 100 feet. Occupies hillocks, rounded hills, or ridges from 2 to 200 feet in height. Found along shores of lakes, rivers, or oceans and in deserts. Usually of no agricultural value on account of the irregular surface, the loose open nature of the material, the small water-holding power, and the unstable and drifting nature of the soil. In arid regions, when leveled and under irrigation, it is often very productive, especially for small fruits and vegetables. The encroachment of these sands on cultivated fields, orchards, cranberry bogs, and even upon houses, towns, and harbors is often a serious problem, and much experimentation and labor has at times been expended in binding them with grasses and trees to prevent their shifting.

	1	2	3	4
Soil (2)	25	71	2	2
Subsoil (1)	13	83	1	1

	Acres.		Acres.
Allegan County, Mich	3,130	Los Angeles, Cal	3,264
Imperial, Cal	116,288	Lower Arkansas Valley, Colo	3,328
Indio, Cal	8,256	Ventura, Cal	2,020

Sandhill.—Coarse, loose, incoherent sand, 10 feet or more in depth. Occurs in hills from 20 to 200 feet or more in height, either as long, narrow ranges or frequently as isolated hills, representing old shore lines of the ocean or formed by river action and wind. Soil generally more stable than the Dunesand. Material is generally so loose and incoherent and so thoroughly drained that it has little agricultural value. In humid regions it supports a growth of stunted oak and pine. In the arid regions there is some little pasturage. Occasionally valleys or low places produce fair crops of vegetables. Peaches are grown to a slight extent, but this type generally is unproductive.

	1	2	3	4
Soil (3)	55	36	5	2
Subsoil (1)	66	27	3	4

	Acres.
Darlington, S. C	30,656
Raleigh to Newbern, N. C	5,320

Riverwash.—Coarse sand, gravel, and bowlders generally in long, narrow areas, but occasionally spread out in fan-shaped areas. Subject to overflow in times of flood, occupying bottoms of flood channels of rivers. Liable to be encountered, particularly in the far West, where torrential rains occur and rivers vary greatly in volume and quickly subside, giving little chance for fine material to be deposited. No agricultural value.

	Acres.		Acres.
Blackfoot, Idaho	1,792	San Gabriel, Cal	16,230
Fresno, Cal	480	San Jose, Cal	128
Jamestown, N. Dak	17,408	Sevier Valley, Utah	[a]3,200
Laramie, Wyo	1,792	Solomonsville, Ariz	256
Los Angeles, Cal	1,664	Ventura, Cal	13,610
Lower Arkansas Valley, Colo	12,800	Yakima, Wash	3,580
Lower Salinas Valley, Colo	10,760		

Madeland.—Areas are occasionally encountered where soils have been filled in over considerable tracts in mining operations and in the improvement of harbors. Such areas do not fit into any soil group, and yet it is advisable to recognize them on the soil map. They are of no present agricultural value.

	Acres.
Syracuse, N. Y	576

Rock outcrop.—Areas in the main either rock outcrop or so stony as to be entirely unfit for cultivation and incapable of being put into condition for cultivation. In this respect it differs from stony areas, which can be improved to some extent for agricultural purposes. Rock-outcrop areas, however, often support timber and afford some grazing.

	Acres.		Acres.
Asheville, N. C	1,856	Mount Mitchell, N. C	5,184
Baker City, Oreg	192	Parsons, Kans	2,368
Bedford, Va	17,140	Pikeville, Tenn	14,016
Campobello, S. C	1,997		

Rough, stony land.—Under this head have been classed areas so stony and broken as to be of little agricultural value, but yet not so barren as Rock outcrop areas. In Johnson County, the first area where this classification has been followed, the areas are

[a] Part mapped as Elsinore sand in Sevier Valley, but this name will not again be used.

usually narrow strips winding through the county or forming bluffs along streams. This land is used solely for pasture, and very little of it can ever be used for anything else. Supports some forest growth.

	Acres.
Johnson County, Ill	16,384

INLAND SWAMPS AND MEADOWS.

Under this head will be described soils of a miscellaneous nature, occurring along streams or in depressions, and inclined to be wet from insufficient drainage; fresh-water swamps in which drainage conditions are still more deficient so that the land is actually covered with water for much of the time through an actual inability to drain itself rather than from the flood waters of rivers; and peat and muck, which are an advanced stage of swamp, where drainage is partly established after a long period of growth of water-loving vegetation. This classification depends mainly upon the drainage conditions.

Meadow.—This term is used for low-lying, flat, usually poorly drained land along streams and embayments and in depressions. Generally adapted to grass and pasturage and used for general farming where artificially drained. The areas being usually small and narrow, and subject to frequent overflow, show great variation in texture and character of material, but being usually moist the influence of the texture is not so apparent as in upland soils. The similarity of crop value dependent upon moisture conditions is the controlling factor in this classification.

	Acres.		Acres.
Albemarle, Va	40,640	Cerro Gordo, Iowa	3,456
Abbeville, S. C	6,336	Cobb County, Ga	30,280
Alamance, N. C	15,970	Connecticut Valley, Connecticut and Massachusetts	[a]55,232
Allegan County, Mich	15,510	Covington, Ga	16,410
Asheville, N. C	7,808	Dover, Del	4,096
Ashtabula, Ohio	12,160	Dubuque, Iowa	4,160
Bedford, Va	3,530	Fort Valley, Ga	4,800
Bigflats, N. Y	1,920	Fresno, Cal	5,478
Calvert, Md	15,800	Gadsden County, Fla	52,224
Campobello, S. C	8,691	Grand Island, Nebr	28,544
Cary, N. C	3,180		

[a] Mapped as Connecticut Meadows. Should probably have been given a type name, as it is an alluvial soil rather than a meadow in the sense in which this term is used.

	Acres.		Acres.
Harford, Md	4,440	Ouachita, La	13,440
Hickory, N. C	23,872	Perry County, Ala	53,696
Huntsville, Ala	42,240	Pontiac, Mich	4,032
Jacksonville, Tex	2,624	Prince Edward, Va	19,880
Jamestown, N. Dak	4,992	Prince George, Md	30,870
Janesville, Wis	18,112	Pecos Valley, N. Mex	[a] 7,940
Kent County, Md	49,230	Raleigh to Newbern, N. C	6,330
Lancaster County, Pa	6,000	St. Mary County, Md	54,200
Lebanon, Pa	4,780	Salem, N. J	52,250
Leesburg, Va	18,048	Salt Lake, Utah	[b] 6,840
Lockhaven, Pa	896	Sevier Valley, Utah	10,200
Long Island, N. Y	16,768	Shelby, Mo	36,416
Lufkin, Tex	4,288	Smedes, Miss	17,408
Lyons, N. Y	35,008	Statesville, N. C	18,850
McNeill, Miss	6,976	Story County, Iowa	18,048
Madison County, Ind	10,816	Trenton, N. J	44,800
Marshall, Minn	448	Viroqua, Wis	7,104
Mason County, Ky	832	Westfield, N. Y	4,990
Mobile, Ala	78,528	Willis, Tex	1,510
Montgomery County, Ohio	7,200	Winnebago County, Ill	44,800
Mount Mitchell, N. C	6,976	Woodville, Tex	5,568
Nacogdoches, Tex	5,056	Yakima, Wash	15,060
Ogden, Utah	7,700	Yazoo, Miss	4,760

Swamp.—A condition of soil too wet for any crop, covered with standing water for much or all of the time. Soil varies in texture and in organic content, which, however, is invariably high. Occurs in flat areas with deficient underdrainage. Native growth, water-loving grasses, herbs, shrubs, or trees. Almost invariably productive when drained and properly cultivated. Adapted particularly to corn, potatoes, cabbages, onions, celery, cranberries, or peppermint, according to the locality.

	Acres.		Acres.
Acadia, La	1,728	Lower Arkansas Valley, Colo	640
Billings, Mont	3,008	Miller County, Ark	2,240
Calvert County, Md	3,600	Norfolk, Va	12,928
Craven, N. C	188,288	Pontiac, Mich	704
Connecticut Valley, Connecticut and Massachusetts	25,216	Raleigh to Newbern, N. C	[c] 77,440
Darlington, County, S. C	14,144	St. Mary County, Md	2,200
Dover, Del	3,712	Syracuse, N. Y	12,480
		Worcester County, Md	26,048

[a] Mapped as Hondo Meadows. This name will not be used hereafter.

[b] Mapped as Jordan Meadows. This name will not be used hereafter.

[c] Part of this mapped as Pocoson and part Savanna in the original report. These names will not be used hereafter to designate soil types.

Peat.—Vegetable matter consisting of roots and fibers, moss, etc., in various stages of decomposition, occurring as turf or bog, usually in low situations, always more or less saturated with water, representing an advanced stage of swamp with drainage partially established.

	Acres.		Acres.
Bigflats, N. Y	576	Santa Ana, Cal	787
Los Angeles, Cal	1,088	Tazewell County, Ill	1,664

Muck.—Vegetable mold, more or less thoroughly decomposed and mixed with earth, from 1 to 3 or more feet deep, occupying low, damp places. May be considered an advanced stage of peat, in which the roots, fiber, and moss characteristic of peat have been so far decomposed as to lose their original structure. When drained these soils are exceedingly productive and adapted to corn, potatoes, cabbages, onions, celery, peppermint, and similar crops.

	Acres.		Acres.
Allegan County, Mich	33,770	Madison County, Ind	1,152
Baker City, Oreg	12,352	New Orleans, La	21,056
Cerro Gordo County, Iowa	12,096	Pontiac, Mich	3,904
Grand Forks, N. Dak	6,592	Raleigh to Newbern, N. C	623
Janesville, Wis	10,368	Syracuse, N. Y	16,960
Lyons, N. Y	3,840	Winnebago County, Ill	2,176

ATLANTIC AND GULF COASTAL PLAINS SOILS.

The Atlantic Coastal Plain, one of the important physiographic provinces of the eastern United States, is represented by a narrow belt bordering the New England coast, widening out in New Jersey, the line of contact between this and the Piedmont Plateau passing through Trenton, Baltimore, Washington, Richmond, Raleigh, Columbia, Augusta, and Savannah, meeting the Gulf Coastal Plain, which extends around to the Mexican boundary line. The surface is that of a more or less dissected plain with large tidal estuaries, particularly in Maryland and Virginia. In these two States the uplands reach an elevation of 200 or 300 feet above tide, while in the more southern localities the elevations rarely exceed the former figure and for the most part are not over 60 or 75 feet. Over large areas in North Carolina, South Carolina, and Georgia the mean fall toward the ocean is hardly more than 1 foot to the mile. In such level areas drainage is apt to be defi-

cient, and rain water remains upon the surface for a considerable time, although the conditions are not comparable with those of a true swamp. In such areas the soil, although it may be composed largely of sand, is apt to be very compact, deficient in organic matter, and generally unproductive. Nearer the coast the lands have better drainage, are looser and more easily cultivated, and their productivity is more easily maintained. From Virginia northward the surface is more broken, in many places hilly, and better drainage is thereby provided.

The soils have been derived mainly from the wash from the Piedmont Plateau and the mountains beyond, laid down under water, the surface having been several times submerged and elevated. The soils are for the most part composed of light sands and loams, with occasional deposits of sandy clays, and silt, and very local surface deposits of heavy clays. There are very few soils in this division which approach in texture or compare in productiveness or crop value with the heavy clays of the Piedmont Plateau or of the residual limestone valleys. They are, therefore, not as well adapted to general farm crops, nor can they be expected to give as satisfactory yields of such crops as corn, wheat, oats, or hay; but, on the other hand, they are eminently adapted to the production of early vegetables, the lighter farm crops, particularly fine qualities of peaches and small fruits, and a fine-textured cotton, together with rice and citrus fruits where the climatic and drainage conditions are suitable.

The Gulf Coastal Plain is characterized by very large deposits of silty and heavy clay soils, although the coarse sandy soils also occur over very large areas. The great black calcareous prairies of the Gulf Plain and the vast Gulf coast prairies which are being so extensively developed at the present time in the rice and sugar-cane industries have no prototypes in the Atlantic Coastal Plain. These extensive prairies are composed of very heavy clay soils.

Immediately bordering the ocean and Gulf coast is frequently found a stretch of tidal marshes, covered with water at every tide, or at least in unusual tides, supporting usually a growth of coarse salt grass. This material consists of sands, loams, and clays included under the Galveston Series. On account of the extreme difficulty of access and the present low value of these lands the soil survey

is carried on in them with less detail than in other areas; still, where the areas are large and have not been subject to local stream erosion the character of the material is not subject to very much local change. The agricultural value of these lands is very small, depending mainly upon the pasturage afforded and the coarse hay that can with difficulty be harvested; and, on the other hand, they are a distinct menace to health, as they form the breeding place of disease-carrying insects. Efforts have been made to drain such soils and to reclaim these marshes with great success, the possibilities of successful reclamation, however, depending upon the engineering problems connected with the keeping out of the tides and the efficient subsequent drainage of the land. A vast amount of such reclamation work has been done in Holland, and some important though relatively small areas have been reclaimed in the United States.

Other members of this group are the inland swamps, muck, and meadow areas.

GALVESTON SERIES.

Galveston sand.—Light gray to white sand, 12 inches in depth, containing usually a large percentage of fine particles of shell. Subsoil is of same character as soil, a little lighter in color, and with larger shell fragments. Occurs as a narrow ridge along coasts, the texture being due to wave action. Generally unproductive and nonagricultural.

	1	2	3	4
Soil (2)	31	69	0	0
Subsoil (2)	30	71	0	0

	Acres.		Acres.
Brazoria, Tex	1,152	Norfolk, Va	[a]10,752
Dover, Del	64	Worcester County, Md	8,064
Long Island, N. Y	12,224		

Galveston sandy loam.—Surface mass of sandy loam and eel-grass turf about 12 inches deep, underlain by gravelly sandy loam. Occupies shore lines and barrier beaches, and owes its origin to wind-blown sand, mixed with the finer materials of the coastal flats. Where diked and drained, makes a productive soil much lighter

[a] This includes some Dunesand, but the whole area is of so little agricultural importance that the two types were not separated.

and easier to cultivate than the Galveston clay. It is adapted to the same crops as the latter soil, and on account of the easier cultivation and the less compact nature of the material is rather more desirable as an agricultural soil. Very small areas have been reclaimed in this country.

	1	2	3	4
Soil (1)	23	29	29	18

	Acres.
Long Island, N. Y	16,448

Galveston clay.—Soil varies from a drab or yellow to black clay and rests on a subsoil of still heavier clay. Both soil and subsoil usually contain calcareous nodules. Country very level, flat. Drainage poor, representing the type of salt marsh extensively developed along the sea coasts. Vegetation almost entirely salt grass, affording a rather poor pasturage. Areas require to be diked and drained before reclamation is possible, and when so reclaimed and the excess of salt removed they make exceedingly productive soils, especially for corn, cabbage, onions, rice, and hay crops.

	1	2	3	4
Soil (10)	9	20	36	35
Subsoil (8)	8	20	38	34

	Acres.		Acres.
Brazoria, Tex	31,168	New Orleans, La	5,504
Dover, Del	30,784	San Jose, Cal	26,048
Long Island, N. Y	36,352	Worcester County, Md	23,936
Los Angeles, Cal	4,800		

NORFOLK SERIES.

This series consists of light-colored sands and loams, and comprises the most important truck soils of the Atlantic and Gulf coasts.

Norfolk gravel.[a]—Hills and narrow bands of gravel. The soil is gray loam about 12 inches deep, containing 30 to 60 per cent of rounded white quartz gravel. The subsoil varies, but is usually clay or gravel beds. Formed from denudation of gravel layers deposited as shallow-water sediment or as river wash or delta. It

[a] Mapped as Susquehanna gravel. This name, however, will be used only in Maryland in the future.

is a poor, unproductive soil, generally occupying slopes and should remain in forest.

	Acres.		Acres.
Calvert County, Md	3,900	Prince George County, Md	41,470
Cecil County, Md	45,600	Raleigh to Newbern, N. C	11,410
Harford County, Md	12,930	St. Mary County, Md	7,350
Kent County, Md	12,490	Trenton, N. J	192
Long Island, New York	3,328		

Norfolk gravelly loam.—Yellowish or gray loam 4 to 8 inches deep, underlain usually by a still more gravelly material. The gravel is usually small, deposited by swiftly flowing streams; sloping plains or terraces; quite unproductive; some corn, rye, buckwheat, truck crops, and wrapper tobacco, according to location.

	1	2	3	4
Soil (9)	27	38	25	8
Subsoil (6)	15	41	31	10

	Acres.
Connecticut Valley, Connecticut and Massachusetts	[a] 48,384
Lancaster County, Pa	[b] 4,000
Lebanon, Pa	[b] 13,350

Norfolk coarse sand.—Coarse to medium sand, 8 inches deep, loose and incoherent in texture, and containing some gravel. Subsoil same, frequently containing iron crusts. Occurs as level plains. Very unproductive, but used to some extent for tobacco, peaches, and truck.

	1	2	3	4
Soil (12)	56	28	10	4
Subsoil (15)	58	29	8	4

	Acres.		Acres.
Calvert County, Md	[c] 24,500	Prince George County, Md	[c] 37,420
Connecticut Valley, Connecticut and Massachusetts	[c] 42,048	St. Mary County, Md	[c] 3,450
Long Island, N. Y	1,856	Salem, N. J	[c] 18,280
		Trenton, N. J	[c] 512

[a] Mapped as Chicopee gravel loam. This name will not be used again.
[b] Mapped as Donegal gravelly loam. This name will not be used again.
[c] Mapped as Windsor sand, which name will not again be used, except in Maryland.

Norfolk coarse sandy loam.—Medium sand mixed with a large quantity of small gravel. Naturally rather unproductive on account of dry nature.

	1	2	3	4
Soil (5)	44	23	24	9
Subsoil (4)	70	15	9	5

	Acres.
Connecticut Valley, Connecticut and Massachusetts	27,904
Long Island, N. Y.	64,896

Norfolk sand.—Coarse to medium gray or yellowish sand, friable and incoherent, resting on a yellow sand of about the same texture, 3 feet or more in depth. A common type on the low, flat river necks and forelands of the Atlantic and Gulf coastal plains; also along the valley slopes of the streams and covering extensive level areas in the uplands. It is well drained, matures crops very early, and has such a small retentive power for water that general farm crops can not be grown with any great success. Corn yields but 5 to 10 bushels per acre and wheat not to exceed 5 to 6 bushels. It is a typical early truck soil, especially adapted to light truck crops. It is also used for small fruits and peaches, although not so well adapted to these latter as some of the other soils of the series. Many watermelons are grown upon this soil in the Southern States. In the Connecticut Valley and in Florida a very fine grade of cigar wrapper tobacco is produced upon this soil. In Maryland it produces a fine grade of the Maryland export tobacco. In North and South Carolina it produces a very fine grade of cigarette tobacco, but is not as well adapted to this as is the Norfolk sandy loam.

	1	2	3	4
Soil (53)	32	52	11	4
Subsoil (42)	32	50	11	6

	Acres.		Acres.
Calvert County, Md.	58,000	Long Island, N. Y.	77,120
Cecil County, Md	46,600	Mobile, Ala	134,592
Connecticut Valley, Connecticut and Massachusetts	[a]40,384	Norfolk, Va	20,864
Craven, N. C	88,192	Perry County, Ala.	4,160
Darlington, S. C.	71,104	Prince George County, Md	23,630
Dover, Del	5,632	Raleigh to Newbern, N. C	53,310
Fort Valley, Ga	33,792	St. Mary County, Md.	27,500
Gadsden County, Fla.	93,120	Salem, N. J.	78,410
Harford County, Md	2,470	Trenton, N. J.	50,880
Kent County, Md	30,760	Willis, Tex	8,560
		Worcester County, Md	45,312

[a] Mapped as the Hartford sandy loam, which name will not be used again outside of the Connecticut Valley.

Norfolk fine sand.—Fine, brown loamy sand, about 8 inches deep, loose and friable when dry, but packing slightly when wet. Subsoil is of much the same character, slightly more loamy and somewhat more adhesive. Occurs as low, rolling hills and level areas. Generally well drained, adapted to about the same class of truck crops as the Norfolk sand, but generally somewhat more productive. Produces only fair crops of corn. In Florida a fine grade of wrapper tobacco is grown on this soil.

	1	2	3	4
Soil (11)	13	66	13	6
Subsoil (19)	14	63	15	7

	Acres.		Acres.
Jacksonville, Tex	38,528	Salem, N. J	[b] 15,710
Ouachita, La	192	Trenton, N. J	[b] 27,584
Prince George County, Md	[a] 36,190	Worcester County, Md	22,400

Norfolk sandy loam.—Coarse to medium yellow or gray sand, 12 to 20 inches deep, generally loose and incoherent, resting on a yellow sandy clay. Level or gently rolling land. Soil is too light for general farm crops. Corn yields on the average not over 10 bushels per acre. It is adapted to sweet and Irish potatoes, peanuts, and late truck crops. In the Connecticut Valley and in Florida it produces a fine cigar wrapper tobacco and in North Carolina bright yellow tobacco and cotton.

	1	2	3	4
Soil (16)	29	48	16	6
Subsoil (12)	24	36	18	21

	Acres.		Acres.
Connecticut Valley, Connecticut and Massachusetts	[c] 13,312	Gadsden County, Fla	50,816
Craven, N. C	27,218	Raleigh to Newbern, N. C	[e] 216,580
Darlington, S. C	[d] 65,024	Salem, N. J	[f] 16,790
Fort Valley, Ga	23,488	Trenton, N. J	[f] 8,640
		Woodville, Tex	52,864

Norfolk fine sandy loam.—Fine, pale yellow or gray sandy loam, 12 to 18 inches deep, underlain by a reddish-yellow fine sandy loam

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[a] Mapped as Westphalia sand, which name will not again be used.

[b] Mapped in part as Elsinboro fine sand and in part as Westphalia sand, neither of which names will again be used.

[c] Mapped as Enfield sandy loam, which name will not be used outside of the Connecticut Valley.

[d] Mapped as Norfolk sandy soil, which name will not be used hereafter.

[e] Mapped in part as Norfolk sandy soil and in part as Selma silt loam, which latter name will not be used hereafter.

[f] Mapped as Quinton sandy loam, which name will not be used hereafter.

grading into a sandy clay at an average depth of about 20 inches. Level plains and along streams. The latter areas are subject to occasional overflow. Drainage generally good. Gives a moderate yield of corn, and is very well adapted to late truck crops, in the South to cotton, in North Carolina to bright yellow tobacco, and in Texas to cigar wrapper leaf. This soil is not as valuable for truck as the Norfolk fine sand, nor as good a cotton soil as the Norfolk sandy loam, but is esteemed a better tobacco soil than the latter and fully equal if not somewhat superior to the former.

	1	2	3	4
Soil (34)	12	53	26	8
Subsoil (32)	10	42	22	24

	Acres.		Acres.
Calvert County, Md	[a]5,220	Mobile, Ala	7,168
Craven, N. C	155,136	Nacogdoches, Tex	19,008
Darlington, S. C	[b]25,600	Norfolk, Va	38,144
Gadsden, Fla	28,096	Prince George County, Md	[a]9,660
Lufkin, Tex	6,016	Raleigh to Newbern, N. C	36,100
McNeill, Miss	81,472	St. Mary County, Md	[a]8,500
Mason County, Ky	832	Willis, Tex	[c]107,180

Norfolk loam.—Brown loam or sandy loam, usually containing a very small amount of fine gravel. The subsoil is a yellow loam containing considerable coarse sand. This is frequently underlain by a medium grade of yellow sand or by gravel. The type occupies level areas, usually terraces along rivers and tidal estuaries. The soil is easily tilled, well drained, and produces fair yields of general farm crops. It is especially well adapted to sugar corn, peas, and tomatoes for canning purposes, and also to peaches. It is too heavy a soil for early truck, and not sufficiently heavy to be classed as a general farming soil.

	1	2	3	4
Soil (32)	16	40	21	11
Subsoil (32)	15	36	9	19

[a] Mapped as Norfolk loam, but now brought into the proper place in the Norfolk series.

[b] Mapped as Ayden fine sandy loam, which name will not be used hereafter.

[c] Part of this occurring on the uplands was mapped as Willis sand, the remainder occupying a low position along the river was mapped as Norfolk fine sandy loam. It is recognized now that these two areas should have been combined.

	Acres.		Acres.
Calvert County, Md	[a] 10,900	Norfolk, Va	23,872
Dover, Del	66,752	Perry County, Ala	[a] 14,720
Lockhaven, Pa	3,648	Prince George County, Md	[a] 17,500
Long Island, N. Y	[a] 100,096	St. Mary County, Md	[a] 4,830
Mason County, Ky	896	Worcester County, Md	[a] 54,848
Mobile, Ala	47,104		

Norfolk silt loam.—A brown loam 10 inches deep, underlain by a heavy yellow loam subsoil, both containing a rather high percentage of silt. Occurs as level or gently rolling upland or terraces. Esteemed the most valuable soil of the Atlantic Coastal Plain for general farm crops. Adapted to wheat, corn, and grass. In New Jersey this soil produces as high as 25 or 35 bushels of wheat, 1 to 2 tons of hay, and from 50 to 70 bushels of corn per acre. It is esteemed an excellent soil for dairy farming. On the Eastern Shore of Maryland the yields are almost as high as in New Jersey. In southern Maryland the yields are much less, wheat producing from 12 to 18 bushels, and corn 25 to 40 bushels per acre, while the yield of hay is proportionally small. It is believed that this difference in productiveness is due almost entirely to the methods of cultivation.

	1	2	3	4
Soil (40)	14	24	47	13
Subsoil (40)	51	21	43	19

	Acres.		Acres.
Calvert County, Md	[b] 8,850	Lockhaven, Pa	5,824
Cecil County, Md	[b] 50,500	Prince George County, Md	[b] 9,090
Darlington, S. C	[b] 26,880	Salem, N. J	[c] 108,140
Dover, Del	32,960	St. Mary County, Md	[b] 16,200
Harford County, Md	[b] 29,810	Trenton, N. J	[c] 88,384
Kent County, Md	[c] 67,200	Worcester County, Md	[b] 14,400

[a] Mapped in part as Sassafras sandy loam and in part as Sassafras gravelly loam, which names will hereafter only be used in Maryland and New Jersey.

[b] Mapped as Sassafras loam. It is recognized clearly now that this belongs to the Norfolk series. The name Sassafras loam will be used hereafter only in Maryland and New Jersey.

[c] Mapped in part as Sassafras loam and Sassafras gravelly loam. The latter name will not again be used, and similar soils will in the future be mapped as Norfolk silt loam with a gravel symbol and the gravelly phase described in the report, except in Maryland and New Jersey, where it will be mapped as Sassafras loam with a gravel symbol. The silt content of this soil, as shown by the averages, is rather low for a silt loam, but in many individual samples

MISCELLANEOUS SOILS ASSOCIATED WITH THE NORFOLK SERIES.

There are a number of soils found in the Coastal Plain which can not be grouped with the Norfolk series or, so far as now known, with any other series. They are derived in part from peculiar geological formations or have been formed under purely local conditions. They are liable to be encountered wherever the Norfolk series occurs, and should properly follow in this place in the general classification of soils.

Garner stony loam.—A sandy loam containing 40 to 60 per cent of rock fragments and gravel, mainly iron-stained sandstone. At a depth of 6 to 15 inches it overlies a red, tenacious brick-clay subsoil, which also contains sand, gravel, and stones. It is found along stream courses, and probably owes its origin to stream action at times of overflow. Tillage is difficult, but fair crops of cotton can be raised. It is devoted to the growth of commercial pine timber, and used for hog and cattle pastures.

	1	2	3	4
Soil (1)	39	36	14	7
	Acres.			
Raleigh to Newbern, N. C.	14,330			

Gadsden sand.—Dark-gray sand, 10 inches deep, underlain by a gray or brownish sand appearing lighter in texture and extending to a depth exceeding 36 inches. The sand is of medium to fine texture, and there is usually a considerable admixture of organic matter. Lies on gentle slopes or undulations adjacent to streams. Mainly hammock land, with growth of hard wood. Very productive, but requiring careful treatment to maintain the yields. One of the best soils for the Florida wrapper tobacco.

	1	2	3	4
Soil (2)	26	66	4	4
Subsoil (2)	24	66	5	6
	Acres.			
Gadsden, Fla.	45,248			

Lufkin fine sand.—The soil is a fine gray sand about 10 inches deep, resting on a subsoil of much the same character but occasion-

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the content is as high as 60 or 70 per cent, while in many others it falls as low as 25 or 30 per cent. It is thus seen that this is a type of widely varying silt content, but in relation to other soils of the Coastal Plain it may well be classed as a silt soil.

ally more loamy. At a depth of from 3 to 5 feet occurs a gray or mottled stratified clay. Generally well drained, but occasionally small areas occur as depressions, where the drainage is deficient. Such areas are locally referred to as "crawfish land." The natural growth is scrub pine and oak. Produces fair yields of corn and cotton, but is rather better adapted to early truck crops and peaches. Soil needs green manuring for the incorporation of more organic matter.

	1	2	3	4
Soil (3)	2	58	37	3
Subsoil (3)	2	56	36	6

	Acres.
Lufkin, Tex	39,680

Podunk fine sandy loam.[a]—Fine sandy loam, 12 inches deep, underlain by fine sand. Level terrace of the Connecticut Valley. Lacustrine deposit. Rather light for general farm purposes, but well adapted to present type of broad leaf wrapper tobacco.

	1	2	3	4
Soil (3)	3	62	31	5
Subsoil (5)	4	74	18	3

	Acres.
Connecticut Valley, Connecticut and Massachusetts	13,824

Collington sandy loam.—Loose, loamy, brown sand, usually containing considerable coarse sand, 9 to 20 inches deep, derived from weathering of green glauconite sand, underlain by sticky yellow or greenish-yellow claylike material with glauconite particles. At 30 to 40 inches greensand, in original purity, occurs. Very productive area, "Forest of Prince George," Maryland. Used for general farming; excellent for small fruits, nurseries, and truck. Good tobacco soil. Contains large amount of potash (2.5 per cent). Same soil is derived from Cretaceous greensand in New Jersey, where it is used for general farming and truck production.

	1	2	3	4
Soil (9)	27	49	13	8
Subsoil (10)	20	44	12	21

	Acres.
Prince George County, Md	23,260
Salem, N. J	4,170
Trenton, N. J	83,456

[a] This should have been called the Podunk fine sand.

Monroe fine sandy loam.—A mellow, brown fine sandy loam from 10 to 20 inches deep, with an average depth of 15 inches. The subsoil is a fine reddish-brown loam, somewhat sticky in texture, extending to a depth of more than 36 inches. Terrace formation along streams. Very productive soil, adapted to cotton and corn. The former yields from one-half to $1\frac{3}{4}$ bales per acre and the latter from 20 to 40 bushels. Also adapted to fruit and vegetables.

	1	2	3	4
Soil (4)	0	46	49	5
Subsoil (4)	1	37	53	10

	Acres.
Ouachita, La	86,272

Myatt fine sandy loam.—Gray sticky fine sand to a depth of 10 inches. Subsoil is a drab or gray sandy clay of a tough consistency, usually containing a large percentage of iron concretions. The drab clay is mottled with iron stains. Occurs on lower hillsides and low-lying bottoms. The latter areas are subject to frequent overflow, and drainage is poor. Very little of this soil has been encountered under cultivation. The natural growth is gum, cypress, and oak, the latter making some very fine timber. The crop yields are only moderate, although with proper drainage and good treatment it is believed this soil could be brought to a good state of productiveness.

	1	2	3	4
Soil (2)	12	44	38	8
Subsoil (2)	9	30	40	22

	Acres.
Ouachita, La	8,064

Elmwood loam.[a]—Dark-brown fine sandy loam, 2 feet in depth, overlying close, poorly drained clay. Level terraces along Connecticut River. Lacustrine deposit. Has very little present agricultural value on account of compact nature and poor underdrainage.

	Acres.
Allegan County, Mich	3,810
Connecticut Valley, Connecticut and Massachusetts	7,168

[a] This soil is also likely to be encountered among the glacial soils.

Hempstead loam.—A friable brown or black loam, 8 inches deep, containing a small amount of white quartz gravel and locally becoming somewhat sandy. The subsoil, to a depth of 24 inches, consists of a heavy yellow or reddish silty loam, slightly gravelly. This is underlain by a bed of rounded quartz gravel embedded in a sandy loam matrix, all considerably stained with iron. Generally level areas. Well underdrained by the gravel beds, but the soil maintains a fair supply of moisture. The chief trouble is the lack of depth. No forest cover, but affords fair pasturage in its uncultivated state. Produces good crops of corn, potatoes, tomatoes, cabbage, rye, and grass. Also a fair soil for late truck crops. In the Long Island area the Hempstead loam is second in value only to the Miami stony loam.

	1	2	3	4
Soil (3)	14	17	48	21
Subsoil (3)	14	19	44	22

	Acres.
Long Island, N. Y.	[a]53,824

Sanders loam.—The soil is a dark-brown, reddish-brown, or gray loam. The subsoil is lighter in color and apparently heavier in texture. Occurs as narrow strips along the creeks, extending up the edge of the valleys. Frequently has Sharkey clay on the stream side, which interferes with proper drainage. Is considered a very good corn soil, producing as much as 45 bushels per acre where well drained. Not considered so good for cotton, producing about one-half bale per acre. Soil generally is in need of drainage.[b]

	1	2	3	4
Soil (3)	3	34	44	15
Subsoil (3)	3	46	33	18

	Acres.
Paris, Tex	10,112

Gadsden loam.—Dark yellowish-gray loam, rather light in character, from 8 to 18 inches deep, underlain by a yellowish-gray fine loam or silty loam, somewhat heavier in texture. Occurs as moderately

[a] Part of this has been mapped as Hempstead gravelly loam. It should have been mapped as Hempstead loam with gravel symbol, and the gravelly phase described as such in the report.

[b] This soil is very similar to the Myatt fine sandy loam and the Monroe fine sandy loam, but contains rather more clay than either of those soils.

high bottoms and bluffs. Locally known as hammock land supporting a growth of hard-wood timber. Well drained and quite productive. Adapted to cotton, corn, and fruit.

	1	2	3	4
Soil (1)	25	26	27	21
Subsoil (1)	20	20	28	32

	Acres.
McNeill, Miss	14,592

Selma heavy silt loam.[a]—Heavy silt loam, 20 inches or more in depth, underlain by a stiff, mottled clay. Low-lying level tracts in Coastal Plain region. Natural drainage is poor, and for this reason the soil is unproductive, but when drained it is good cotton and grass land.

	1	2	3	4
Soil (4)	12	44	29	14
Subsoil (4)	17	33	21	28

	Acres.
Darlington, S. C	15,488
Raleigh to Newbern, N. C	18,980

Susquehanna clay loam.—Yellow or brown loam about 10 inches deep, underlain by a heavy mottled clay subsoil identical with Susquehanna clay. Occupies hills, slopes, and valleys. Adapted to grain and grass crops. Considerable areas yet in oak and pine forest.

	1	2	3	4
Soil (2)	7	17	50	21
Subsoil (1)	3	11	55	26

	Acres.
Prince George County, Md	16,850

Leonardtown loam.[b]—Yellow silty loam, closely resembling loess, 9 inches deep, underlain by red and mottled clay loam with peculiar interlocking clay lenses and pockets of sand. Slightly rolling upland. Good soil for general farming, wheat, and grass land. Much of the area is waste land or grown up in white oak and pine forests, and some of the more level portions need underdrainage. This soil is deficient in organic matter and lime.

	1	2	3	4
Soil (14)	5	20	57	15
Subsoil (14)	6	17	50	23

[a] This soil should have been called Selma loam.

[b] Should have been called Leonardtown silt loam.

	Acres.		Acres.
Calvert County, Md	7,950	Prince George County, Md	[a]49,480
Mason County, Ky	320	St. Mary County, Md	95,500
Norfolk, Va	[a]55,488		

Monroe silt loam.—A fine sandy or silty loam 10 inches in depth, underlain by a yellow or red silty clay, usually mottled with white or brown below 2 feet. Occurs as low terraces or in hills of little elevation. The forest growth is oak and pine. Very little has been cultivated and that with very poor success. Cotton can hardly be made to yield one-half bale per acre, and corn proportionally less.

	1	2	3	4
Soil (2)	1	28	61	11
Subsoil (2)	2	33	48	18

	Acres.
Ouachita, La	39,232

Alloway clay.—Red or gray clay loam 6 inches deep, containing some gravel, underlain by a mottled yellow and gray sticky clay to a depth of 3 feet or more. Rolling upland or bottoms. Derived from Miocene or glacial material—recent sediments. Good grass and wheat lands. Produces fine apples. Difficult to till. Generally in need of underdrainage.

	1	2	3	4
Soil (8)	8	12	45	33
Subsoil (8)	6	14	43	36

	Acres.		Acres.
Lyons, N. Y	16,448	Syracuse, N. Y	24,832
Salem, N. J	10,580	Trenton, N. J	11,904

Mobile clay.—This type consists of a yellow loam, with an average depth of 8 inches, resting on a stiff, plastic yellow clay or sandy clay subsoil extending to a depth of 3 or more feet. The surface is characterized by the presence of many iron concretions. Usually found overlying the materials forming the Orangeburg sandy loam. The surface is flat and marked by many swampy, pondlike depressions covered by a scrubby growth of gum. The drainage is generally poor. The type is best adapted to grain and grass.

[a] Part of this was mapped as Leonardtown gravelly loam. It should have been mapped as Leonardtown silt loam with gravel symbol and the gravelly phase described as such in the report.

	1	2	3	4
Soil (2)	11	49	23	18
Subsoil (2)	10	35	26	26

	Acres.
Mobile, Ala	896

Suffield clay.—Clay loam, 12 inches deep, underlain by close-textured laminated clay. Lacustrine deposit. Very poorly drained. Level areas in Connecticut Valley. On account of poorly drained condition and close structure, it is not adapted at present to any agricultural purposes, although used to some extent for pasturage.

	1	2	3	4
Soil (1)	6	40	30	23
Subsoil (3)	1	11	53	32

	Acres.
Connecticut Valley, Connecticut-Massachusetts	10,240

Susquehanna clay.—Clay loam, 6 inches deep, containing gravel, overlying stiff, tenacious red or white pipeclay. Hills and rolling land on the western border of Coastal Plain region, Maryland and adjoining States. The type is very refractory, hard to cultivate, and has at present little or no agricultural value.

	1	2	3	4
Soil (7)	8	18	37	34
Subsoil (5)	3	14	29	51

	Acres.
Cecil County, Md	11,000
Harford County, Md	4,890
Prince George County, Md	22,360

Elkton clay.—Brown loam, 9 inches deep. Subsoil is heavy mottled yellow and gray clay loam, containing some silt. It is of a dry nature, rather than plastic. Flat areas occurring in lowest Columbia terrace in Cecil and Kent counties, Md., and in similar positions in other areas in Atlantic Coastal Plain. Recognized as good land for general farming purposes when well drained. Frequently needs artificial drainage.

	1	2	3	4
Soil (15)	5	17	58	18
Subsoil (15)	3	16	55	25

	Acres.		Acres.
Cecil County, Md	7,000	Mason County, Ky	896
Dover, Del	6,016	Prince George County, Md	1,450
Harford County, Md	11,370	Salem, N. J	11,240
Kent County, Md	27,840	Worcester County, Md	50,432

Selma clay.—The soil consists of from 3 to 6 inches of heavy very fine sandy loam, underlain by a stiff, mottled yellow clay. The surface is generally level and the soil is poorly drained. The soil almost invariably clods unless plowed in just the proper condition of moisture. Artificial drainage is necessary before crops can be grown. When properly drained and carefully cultivated the soil is quite productive, producing from 1 to 2 tons of hay, 20 to 60 bushels of corn, and a bale of cotton per acre.

	1	2	3	4
Soil (2)	6	38	24	24
Subsoil (2)	5	37	14	34

	Acres.
Craven, N. C	9,600
Fort Valley, Ga	640

Neuse clay.—Dark, tenacious, mottled gray clay, 3 feet or more in depth. Stream deposit often subject to overflow, occurring along stream bottoms in Coastal Plain region of North Carolina. Poorly adapted to agricultural purposes on account of close, sticky nature and poor drainage, but when well drained it is good cotton land.

	1	2	3	4
Soil (5)	8	25	38	24
Subsoil (2)	8	24	35	34

	Acres.
Craven, N. C	1,792
McNeill, Miss	13,120
Raleigh to Newbern, N. C	3,040

Ocklocknee clay.—This soil consists of from 8 to 15 inches of sandy loam of variable texture, resting on a stiff, tenacious clay of dark-yellow, mottled red, or black color. The subsoil contains a noticeable quantity of finely divided quartz rock. Areas lie along the river and are subject to overflow. Very little under cultivation.

	1	2	3	4
Soil (1)	14	48	14	23
Subsoil (1)	12	39	9	40

	Acres.
Gadsden, Fla	3,712

Lufkin clay.—The soil is a fine sand or silt loam, from 3 to 8 inches deep, containing occasionally a few iron concretions. The subsoil is a stiff, impervious red or drab clay, becoming very plastic or mottled at a depth of 30 inches. At a depth of 3 to 5 feet the clay is distinctly stratified. The surface is generally level and the drainage is poor. The natural growth is scrub pine and small oaks. Not adapted to ordinary farm crops, and small yields of corn and cotton are obtained.

	1	2	3	4
Soil (10)	5	38	37	20
Subsoil (11)	3	24	30	43

	Acres.		Acres.
Lufkin, Tex	6,976	Paris, Tex	61,696
Nacogdoches, Tex	5,120	Woodville, Tex	4,416
Ouachita, La	64		

PORTSMOUTH SERIES.

This series consists of black to brown sands and loams, generally rich in organic matter, occupying level, usually slightly depressed areas in the uplands along the outer edge of the Coastal Plain. The soils are undoubtedly the result of former sedimentary deposits modified by swamp conditions in which the drainage has become partially reestablished. To the former swampy condition is due the accumulation of organic matter, particularly in the surface soil, and, as a usual accompaniment of such conditions, the notable lack of organic matter in the subsoil. The same cause has produced the mottled colors in the subsoil which are commonly associated with poor drainage and lack of sufficient aeration, especially where such conditions continue for long periods. The Portsmouth series forms an intermediate class of soils between the Norfolk series of light-colored sands and loams on the one hand and the present swamp areas on the other. The soils of this series, when drained, are admirably adapted to corn and some of the truck crops, particularly to strawberries, cabbage, and onions. They are not well adapted to wheat.

Portsmouth sand.—Black, brown, or gray loamy sand, about 12 inches deep, usually containing a large amount of organic matter. The subsoil is a gray or mottled drab, white, and yellow sticky sand of fine texture, underlain usually at from 24 to 48 inches by

a compact and impervious stratum of sand having the properties of a hardpan. Occasionally this sand is so saturated with water as to resemble quicksand. Occurs in nearly level upland areas with poor drainage. Former lake or swamp deposits. Corn is the principal crop. Adapted to berries, particularly to strawberries; also to cabbage, onions, and other heavy or late truck crops.

	1	2	3	4
Soil (8)	35	51	7	6
Subsoil (6)	40	48	5	6

	Acres.		Acres.
Craven, N. C	11,072	Norfolk, Va	2,048
Dover, Del	640	Worcester County, Md	41,024
Gadsden, Fla	8,640		

Portsmouth sandy loam.—A black, brown, or gray sandy loam about 12 inches deep, frequently containing a very large amount of organic matter, underlain by a gray or mottled sandy clay, which in turn is underlain usually by a compact sand having the properties of a hardpan. Occupies level or slightly depressed areas in the uplands. Drainage usually poor. When drained is adapted to corn, potatoes, and truck crops. Particularly well adapted to strawberries.

	1	2	3	4
Soil (14)	30	36	21	12
Subsoil (11)	21	35	24	20

	Acres.		Acres.
Craven, N. C	46,208	Norfolk, Va	30,016
Darlington, S. C	[a]118,208	Raleigh to Newbern, N. C	[a]37,860
Dover, Del	50,304	Worcester County, Md	9,856

Portsmouth loam.—Dark gray to black sandy loam, 4 to 8 inches deep, underlain by a plastic sandy clay grading into a mottled gray and yellow clay or compact fine sand having the properties of an impervious clay. Flat, usually depressed, upland areas, with naturally very poor drainage. When drained and properly cultivated is well suited to corn, cotton, sugar cane, and forage plants.

	1	2	3	4
Soil (2)	2	33	51	14
Subsoil (2)	2	31	47	21

	Acres.
McNeill, Miss	3,328

[a] Mapped as Goldsboro compact sandy loam, which name will not be used hereafter.

Portsmouth clay.—The soil is a black mucky loam containing a large amount of organic matter. This grades into a gray or dark gray mixture of fine sand and silt which extends for a depth of 6 to 15 inches. This is underlain by a stiff, sticky yellow or mottled clay, quite impervious to water. Occupies flat, generally slightly depressed areas in the uplands, which have very poor natural drainage. When properly drained is a very fine soil for corn or cotton. The former produces as much as 40 to 80 bushels, the latter a bale or more per acre. It also yields well of hay or other forage crops. Some of the late truck crops, particularly cabbage and late varieties of Irish potatoes, are successfully grown, as well as small fruits.

	1	2	3	4
Soil (1)	15	27	50	8
Subsoil (1)	13	22	45	20

	Acres.
Craven, N. C	45,504

ORANGEBURG SERIES.

The Orangeburg series is derived mainly, but not entirely, from the red sand and clays of the Lafayette mantle of the coastal plains. The overlying sands are frequently brown or gray, although typically reddish in part, and are invariably underlain at some depth within 3 feet from the surface by a sandy clay nearly always red, but occasionally yellow, resembling the material underlying the Norfolk series. The characteristic difference between this and the Norfolk series is the prevailing red color of the subsoil. The crop values for corresponding soils in the two series are about the same, but the red clay soils appear to possess a higher fertility and are generally stronger than the corresponding soils of the Norfolk series. The Orangeburg clay and the Norfolk silt loam are comparable as to crop yields, although the former under judicious management and under the same climatic conditions would probably exceed the latter in the production of the staple farm crops. The Orangeburg clay is a prototype of the Cecil clay of the Piedmont plateau. None of the typical Orangeburg clay has as yet been encountered in the areas surveyed, but it has been studied in other areas.

The following is the basis of separation used in the classification of the Orangeburg series:

Orangeburg sand must have at least 15 inches, and not more than 36 inches, of coarse to medium grade sand overlying red sandy clay. When such sand is more than 36 inches, whether or not underlain by a red sandy clay at a lower depth, this material would be called Norfolk sand.

Orangeburg fine sand must have at least 15 inches, and not more than 36 inches, of fine sand overlying red sandy clay.

Orangeburg sandy loam must have more than 4 inches, and less than 15 inches, of coarse to medium sand or sandy loam overlying red sandy clay.

Orangeburg fine sandy loam must have more than 4 inches, and less than 15 inches, of fine sand overlying red sandy clay.

Orangeburg loam must have an average depth of 10 inches of red loam overlying red sandy clay.

Orangeburg silt loam must have an average depth of about 10 inches of red loam with high silt content, underlain by material of the same or heavier character.

Orangeburg clay must have the distinctive red sandy clay of this group within 4 inches of the surface.

These soils usually contain small iron concretions or small pebbles.

Orangeburg sand.—A gray or reddish sand, of medium texture, from 6 to 8 inches deep, usually containing some iron concretions, with a reddish-yellow sandy subsoil, which in turn is underlain at a depth of from 15 to 36 inches by a red sandy clay. Occupies usually gently rolling areas. Has good natural drainage. Gives fair yields of corn or cotton. Adapted to early truck, peaches, and thin wrapper tobacco.

	1	2	3	4
Soil (3)	22	65	6	7
Subsoil (3)	16	55	5	23

	Acres.
Darlington, S. C.	[a]9,984
Gadsden, Fla.	31,552
Perry County, Ala.	[a]196,288

[a] Mapped as Orangeburg sandy loam. The red sandy clay subsoil is too far below the surface in these areas to warrant classing the soil as the Orangeburg sandy loam.

Orangeburg sandy loam.—A coarse to medium red or dark-brown sand, generally loose and incoherent, from 4 to 15 inches in depth, resting on a red sandy clay, usually containing small gravel and iron concretions. Rolling to level upland areas, especially upland ridges and slopes. Adapted to general farming, giving good yields of cotton, corn, and rather small yields of wheat and oats. In South Carolina, adapted to the bright yellow tobacco; in Florida and Texas, to the cigar wrapper and filler leaf. This is the principal peach soil of the Fort Valley area, Georgia.

	1	2	3	4
Soil (15)	22	51	16	11
Subsoil (15)	15	37	15	33

	Acres.		Acres.
Darlington, S. C.	[a]6,592	Paris, Tex.	12,224
Fort Valley, Ga.	24,896	Perry County, Ala.	[b]82,752
Gadsden, Fla.	37,248	Woodville, Tex.	1,152
McNeill, Miss.	7,296		

Orangeburg fine sandy loam.—A fine gray or brown sand from 4 to 15 inches deep, overlying a red sandy clay. Occupies level and rolling to hilly areas in uplands and has good drainage. Well adapted to cotton, gives fair yields of corn, and particularly well adapted to truck crops and peaches.

	1	2	3	4
Soil (18)	6	63	23	8
Subsoil (18)	4	43	20	34

	Acres.		Acres.
Jacksonville, Tex.	18,752	Nacogdoches, Tex.	16,320
Lufkin, Tex.	6,400	Ouachita Parish, La.	172,800
Miller County, Ark.	224,640	Paris, Tex.	69,184
Mobile, Ala.	26,880		

Orangeburg loam.[c]

Orangeburg silt loam.—A brown, red, or chocolate loam containing a high percentage of silt, from 6 to 20 inches deep, underlain by the same material somewhat heavier to a depth of 36 inches,

[a] Mapped as Orangeburg loam, but the surface soil is too coarse, loose, and incoherent for the true Orangeburg loam.

[b] Mapped as Orangeburg clay. The surface soil is too deep for true Orangeburg clay.

[c] The typical Orangeburg loam has not yet been found. The soil mapped under this name in Darlington County, S. C., in 1902, has been correlated with the Orangeburg sandy loam.

frequently grading below this into a fine sandy loam. Occupies level or slightly rolling areas frequently subject to overflow. Well adapted to cotton and corn.

	1	2	3	4
Soil (3)	0	9	66	24
Subsoil (3)	0	13	64	23

	Acres.
Paris, Tex	8,512

Orangeburg clay.—A red loam or clay loam, with an average depth of 8 inches, resting on a stiff, tenacious reddish-brown or red clay. Generally the surface is rolling or hilly and the surface drainage is excellent. Native growth is hardwood. Cotton and corn are the principal crops, the former yielding from one-third to 1 bale and the latter from 15 to 45 bushels per acre. The better areas of this type are believed to be adapted to the production of a fine grade of domestic Cuban filler tobacco.

	1	2	3	4
Soil (12)	10	42	21	24
Subsoil (12)	8	30	19	43

	Acres.		Acres.
Fort Valley, Ga	31,168	Nacogdoches, Tex	16,704
Jacksonville, Tex	4,096	Paris, Tex	59,136

HOUSTON SERIES.

The Houston series occurs in the black calcareous prairies of the Gulf Coastal Plains.

Houston silt loam.—A grayish-brown fine loam, containing a high percentage of silt, 4 to 15 inches deep, underlain by a stiff, rather impervious silt loam or silt clay, varying in color from yellowish-gray to brown. At 5 or 6 feet it usually grades into a soft, rotten material. Occupies level areas, but has good drainage. Used mainly for pasture, but general farm crops do fairly well.

	1	2	3	4
Soil (3)	3	26	54	17
Subsoil (3)	2	16	43	39

	Acres.
Paris, Tex	22,080

Houston clay.—A brown or yellow clay loam from 4 to 8 inches deep, grading into a yellow clay subsoil of a stiff plastic character

and underlain by blue or gray clay. Occupies level or gently rolling country, usually prairie, and owes its origin to Cretaceous sediments. Cracks in summer, but is very plastic when wet. Cotton principal product. Adapted to stock raising. Corn and oats do well.

	1	2	3	4
Soil (6)	7	16	52	24
Subsoil (6)	2	11	45	42

	Acres.
Paris, Tex	40,064
Perry County, Ala	136,128

Houston black clay.—Drab to black clay, 4 to 6 inches deep, friable when well cultivated, but becoming waxy and sticky when wet, and if not continually cultivated caking into a very hard and compact mass that cracks into irregular blocks on drying. Subsoil a waxy, very stiff, and tenacious clay of same color as soil. Both soil and subsoil contain varying quantities of lime concretions, ranging generally from 1 to 10 millimeters in diameter, but frequently larger. Pockets of quartz are also found, and pockets of the drab soil in the black, and vice versa. Very fertile soil. Used commonly for corn, cotton, and rice according to locality, elevation, and drainage. Adapted also to grass.

	1	2	3	4
Soil (9)	2	21	46	28
Subsoil (9)	2	13	48	32

	Acres.
Brazoria, Tex	272,276
Paris, Tex	35,008
Willis, Tex	[a]20,180

VERNON SERIES.

Vernon sand.—A loose, incoherent sand of medium texture, about 18 inches deep, underlain by a looser and coarser material. In color it ranges from a yellow in its least typical phase to a reddish-brown where, on the upland, it contains some organic matter. The river-flat phase contains a little silty material. The upland phase is at times slightly sticky, probably from the presence of lime carbonate. The upland areas are always well drained.

[a] Mapped as San Jacinto clay, which name will not be used hereafter.

Kafir corn, sorghum, and cotton principal crops. Apples, peaches, and melons do well. The lowland phase used for pasturage.

	1	2	3	4
Soil (3)	20	68	8	4
Subsoil (3)	16	66	11	6

	Acres.
Vernon, Tex	56,448

Vernon fine sand.—A loose, fine to medium, gray to reddish-gray sand or sandy loam, resting on a loose sand of medium texture extending to a depth of several feet. River valley soil, and alluvial in origin. While well drained, the soil is more retentive of moisture than would be thought from the loose texture. Principal crops are corn and cotton, the latter yielding about three-fourths of a bale per acre. Corn averages well, the usual yield being about 50 bushels per acre. Higher lying areas are well adapted to fruit, especially peaches. Vegetables also do well, but are grown only for home consumption.

	1	2	3	4
Soil (3)	7	62	26	6
Subsoil (3)	6	60	26	7

	Acres.
Paris, Tex	13,312

Vernon sandy loam.—A dark-red to reddish-brown sandy loam, from 12 to 18 inches deep, mellow, friable, and easily worked. The subsoil to a depth of 36 inches is heavier in texture, and varies from a red to a brown color. Soil is alluvial in origin, and generally well drained. Corn, wheat, Kafir corn, oats, and cotton principal crops.

	1	2	3	4
Soil (2)	16	56	17	11
Subsoil (2)	14	48	22	15

	Acres.
Vernon, Tex	30,592

Vernon fine sandy loam.—A fine brownish-red sand, about 22 inches deep, carrying considerable silt. The subsoil is the same as the soil, except that it is a little lighter in color in the lower depths. From 4 to 6 feet the material is generally a yellowish-red fine sand. Occupies bluffs along rivers. Surface is slightly rolling and the drainage excellent. Derived from wind-blown river

sand when streams were at higher levels. Used principally for pasturage, but adapted to wheat, corn, oats, cotton, and other farm crops.

	1	2	3	4
Soil (2)	1	38	54	7
Subsoil (2)	1	37	53	9

	Acres.
Vernon, Tex	5,248

Vernon loam.—Surface soil is a fine-grained, reddish-brown to dark-brown loam, 12 inches deep, mellow and friable and easily worked. The subsoil is a light reddish-brown loam, heavier in texture than the soil. At from 3 to 6 feet it is underlain by red clay. Occupies level and slightly rolling areas of the prairie upland, is fairly well drained, and is derived from the weathering of material forming the Permian red beds. Corn, wheat, oats, Kafir corn, and sorghum are the principal crops.

	1	2	3	4
Soil (3)	2	26	60	12
Subsoil (3)	3	23	59	11

	Acres.
Vernon, Tex	59,392

Vernon silt loam.—A silt loam about 10 inches deep, underlain by a loose, yellow sand. Occurs upon river flats, usually near bluff line. Poorly drained. Formed by deposits from river. At present used only for pasturage and of little agricultural value.

	1	2	3	4
Soil (2)	1	32	56	11
Subsoil (2)	3	38	47	12

	Acres.
Vernon, Tex	2,880

Vernon clay.—A red clay to heavy clay loam about 9 inches deep, in some localities containing a small percentage of rounded quartz gravel. The subsoil is a heavy, sticky, red clay. It often contains waterworn gravel from 3 to 4 inches in diameter. Derived from the Permian red beds, and is the underlying basal clay of the Vernon loam. Principally used for pasture.

	1	2	3	4
Soil (2)	2	25	59	15
Subsoil (2)	2	19	61	18

	Acres.
Vernon, Tex	22,592

MISCELLANEOUS SOILS OF THE GULF COASTAL PLAINS.

Calcasieu fine sand.—A fine sand or fine sandy loam, 18 inches in depth, underlain by 10 inches of loam bearing some silt and sand, grading into mottled clays. Subsoils often carry iron concretions. Fine sand phase is a loose, incoherent gray or dark sand derived in the deposition of the coastal terrace. Fine sandy loam phase is a yellow sand or sandy loam occupying districts near rivers. Type found in low ridges and pine regions. Adapted to truck and orchard crops.

	1	2	3	4
Soil (5)	1	56	34	8
Subsoil (4)	1	37	34	25

	Acres.
Lake Charles, La	13,970

Calcasieu fine sandy loam.—This type consists of a compact, gray, fine sandy loam from 6 to 18 inches in depth, resting on a clay loam subsoil that grades into a black or yellow clay containing lime nodules and iron concretions. Occurs along streams in very gently rolling areas. A good truck soil and also adapted to pears and berries.

	1	2	3	4
Soil (6)	1	53	36	10
Subsoil (6)	1	39	37	22

	Acres.
Brazoria, Tex	23,040
Lake Charles, La	5,500

Lake Charles fine sandy loam.—A dark-brown or black sandy loam, merging sometimes to light gray, 14 inches in depth; subsoil a loam which grades at 10 inches into a clay loam carrying some silt. Under the clay loam occurs a mottled clay subsoil, often carrying iron or lime concretions. Found on the higher elevations and marked by sand hummocks. Owes its texture to local erosion and admixture of sand from hummock areas. Originally a coastal deposit. Adapted to farm crops requiring light soils and medium drainage.

	1	2	3	4
Soil (10)	2	32	53	11
Subsoil (11)	2	26	47	23

	Acres.
Acadia Parish, La	28,032
Brazoria, Tex	38,784
Lake Charles, La	53,300

Lake Charles loam.—Dark-brown, black, or bluish-black loam, carrying high percentage of organic material. At 14 inches subsoil of clay loam appears, underlain by mottled clay. Origin, local swamp areas, into which fine loam has drifted. A heavy soil, difficult to till. Properly cultivated makes an excellent rice land.

	1	2	3	4
Soil (5)	2	12	52	22
Subsoil (5)	3	12	57	27

	Acres.
Acadia Parish, La	4,608
Lake Charles, La	1,770

Calcasieu loam.—Dark-brown, brownish-gray, or gray silty loam 6 to 16 inches in depth, grading into clay loam 8 inches deep, beneath which are mottled clays. Origin of soil, coastal deposit. Found in poorly drained areas of depression containing scattered sand mounds. Is an excellent rice soil.

	1	2	3	4
Soil (3)	1	22	60	14
Subsoil (4)	1	22	55	20

	Acres.
Lake Charles, La	51,280

Lacasine clay loam.—A heavy brown or black clay loam 20 inches deep, grading into mottled clay, blue generally predominating. Subsoil contains some silt, iron nodules, and sometimes lime concretions. Found in depressions in large swamp areas free from hummocks. A heavy soil, difficult to till and poorly drained, but with lasting properties. This type has no agricultural importance.

	1	2	3	4
Soil (3)	2	24	53	18
Subsoil (3)	0	16	56	24

	Acres.
Lake Charles, La	3,470

Acadia silt loam.—A white or light ash-gray silt and fine sand, from 16 to 30 inches deep, underlain by a silty clay of a mottled brown and yellow color. Occurs in rolling areas. Very little cultivated.

	1	2	3	4
Soil (2)	3	8	69	21
Subsoil (2)	2	4	63	31

	Acres.
Acadia Parish, La	89,280

Almyra silt loam.—Mottled, grayish-brown silty loam about 12 inches deep, resting on material of the same general character, though lighter in color, and grading by degrees through a whitish silt into a reddish-brown clay. Subsoil contains iron concretions and is stained with iron. Occupies level and depressed areas of prairie upland. Poorly drained and difficult to till. Native vegetation, a scattered growth of scrub oak near forested areas; elsewhere, coarse prairie grasses. With proper tillage good yields of oats, corn, cowpeas, sorghum, and Kafir corn are obtained. At present used principally for pasture and wild hay.

	1	2	3	4
Soil (3)	2	5	77	16
Subsoil (3)	2	4	75	19

	Acres.
Stuttgart, Ark	63,104

Landry silt loam.—Dark-brown loam 10 inches deep, underlain by a heavy brown clay loam, grading into greenish-yellow or drab clays. Occupies slightly rolling areas. Has a compact and sometimes chalky structure, but breaks up readily into a white fluffy powder. The subsoil differs from that of the Crowley silt loam in being more friable, less plastic, and having a more noticeable silty texture. The subsoil contains numerous lime and iron concretions. Fertile soil, but surface is so rolling that irrigation is impracticable, and rice culture—the principal industry of the area—is therefore impossible. Fairly well adapted to cotton.

	1	2	3	4
Soil (3)	3	8	70	18
Subsoil (3)	2	5	71	22

	Acres.
Acadia Parish, La	37,696

Crowley silt loam.—Brown or ash-gray loam, composed of fine sand and silt, sufficiently compact to render it rather impervious to water, so that water collecting on the surface usually remains until evaporated. The soil ranges in depth from 10 to 25 inches with an average depth of about 16 inches. The subsoil is a mottled brown and yellow clay containing lime and iron concretions. Below 3 feet it grades into a silty, friable clay. Occurs in level prairies. One of the finest rice soils of south Louisiana. When

well drained is also well adapted to cotton, which, however, has been very little grown.

	1	2	3	4
Soil (3)	2	10	63	25
Subsoil (3)	2	7	60	31

	Acres.
Acadia Parish, La	244,160

Morse clay.—Soil is a heavy silt or clay loam, 6 to 8 inches deep, underlain by a heavy mottled clay, both soil and subsoil being quite calcareous. Occurs along stream courses, and has generally good drainage. Very unimportant soil, difficult to till, and little under cultivation. Adapted to rice where irrigation is possible, and in the well-drained areas is fairly adapted to corn and cotton.

	1	2	3	4
Soil (1)	3	5	52	41
Subsoil (1)	1	4	41	54

	Acres.
Acadia Parish, La	1,664

SOILS OF THE FLOOD PLAINS OF THE MISSISSIPPI RIVER AND ITS LARGER TRIBUTARIES.

A separate place has been given to the extensive characteristic soils encountered in the Mississippi flood plains. While the soils are typical of the Mississippi Valley they have also been found along some of the tributary rivers. There is no sharp distinction, however, between these or other bottom soils found along the rivers of the Middle West. The principal types are comprised in the Yazoo series.

YAZOO SERIES.

Yazoo sandy loam.—Fine to very fine yellow sand, 0 to 6 inches; brown loamy sand, 6 to 12 inches; fine yellow sand, 12 to 40 inches; or, near the margins of areas, underlain by waxy clay below 12 inches. Occupies low, flat ridges, forming front lands near stream courses in river deltas. Chief product is cotton, but soil is suited to truck and market-garden crops. Corn and truck in northern areas.

	1	2	3	4
Soil (22)	3	42	50	8
Subsoil (22)	2	28	56	14

	Acres.		Acres.
Brazoria, Tex	31,872	St. Clair County, Ill	12,800
Clay County, Ill	1,344	Smedes, Miss	8,512
Clinton County, Ill	2,176	Tazewell County, Ill	128
New Orleans, La	41,600	Yazoo, Miss	26,670
Posey County, Ind	2,752		

Yazoo loam.—Yellow or brown loam or silt loam, 0 to 6 inches; drab clay or fine compact sandy loam, 6 to 40 inches. Low ridges in river deltas. Represents higher lying areas of fine sediment deposited by inundations. Strong cotton soil, producing 1 bale per acre. In northern areas adapted to corn and wheat.

	1	2	3	4
Soil (13)	2	20	62	15
Subsoil (12)	2	16	59	22

	Acres.		Acres.
Clay County, Ill	1,472	St. Clair County, Ill	4,160
New Orleans, La	18,112	Smedes, Miss	20,288
Parsons, Kans	28,352	Yazoo, Miss	16,080
Posey County, Ind	8,320		

Yazoo clay.—Heavy drab clay loam 5 inches deep, which sun cracks to a state closely resembling "buckshot land;" subsoil drab clay 5 to 40 inches, usually underlain by sand below 5 or 6 feet. Low areas to rear of front lands and higher ridges in open forest lands in river deltas. Usually would be improved by drainage. Northern areas corn; southern areas finest cotton soil, yielding from $1\frac{1}{4}$ to $1\frac{3}{4}$ bales per acre.

	1	2	3	4
Soil (25)	2	10	55	33
Subsoil (25)	2	10	53	35

	Acres.		Acres.
Brazoria, Tex	9,152	St. Clair County, Ill	26,994
Clinton County, Ill	5,376	Smedes, Miss	37,760
Johnson County, Ill	1,664	Tazewell County, Ill	13,696
New Orleans, La	18,368	Union County, Ky	24,448
Parsons, Kans	68,544	Yazoo, Miss	45,080
Posey County, Ind	30,720		

MISCELLANEOUS SOILS OF THE FLOOD PLAINS OF THE MISSISSIPPI RIVER AND ITS LARGER TRIBUTARIES.

Miller fine sand.—A fine to very fine salmon-colored sand, 6 to 12 inches in depth, and frequently quite loamy from the presence of organic matter. The subsoil consists of 6 inches of loamy sand

or fine sand, resting on a fine sand to very fine sand, uniform in texture to a depth of 36 inches or more. At 6 or 8 feet below the surface a red clay occurs. Occupies river bottoms, but lies above any but the very highest floods. Soil is the result of river sedimentation. Subject to inundation, but is well drained when water in the river is at normal level. Corn yields from 20 to 50 bushels, and cotton one-half to 1 bale per acre. Bermuda grass affords good pasturage and abundant crops of hay.

	1	2	3	4
Soil (2)	1	81	16	3
Subsoil (2)	0	84	13	2

	Acres.
Miller County, Ark	34,688

Miller fine sandy loam.—A gray, brown, or yellow very fine sandy loam, underlain by a subsoil of drab or red clay, having a depth of 36 inches or more. The subsoil frequently grades into a compact silt or sandy loam. Occupies high ridges along streams, or areas at the base of upland escarpments, the greater part being above the reach of floods. Soil is derived from the mixture of river sediments and wash from the uplands. The drainage is not very good. The native vegetation is oak, hickory, ash, elm, and hackberry, with cane brakes along bayous. Cotton and corn are the principal crops, the former on well-drained areas yielding from one-half bale to 1½ bales, and the latter from 20 to 40 bushels per acre.

	1	2	3	4
Soil (3)	2	66	21	11
Subsoil (3)	1	45	33	20

	Acres.
Miller County, Ark	28,544

Arkansas fine sandy loam.—Black or brown fine sandy loam 10 or 12 inches deep resting on a black fine sand grading into a yellow fine sand at from 20 to 24 inches, the latter extending to a depth of several feet. Soil contains a relatively large proportion of organic matter. Occurs on narrow areas along rivers and streams and sometimes in isolated depressions in uplands. The surface is level to gently rolling, and in places is broken by a few low dunes. Generally has good drainage, although some low, depressed areas need artificial drainage. Soil is a river-sediment type, modified to some extent by the addition of wind-blown material. Is a

fairly good agricultural soil, yielding medium crops of wheat and oats, and from 20 to 40 bushels of corn. Sugar beets are grown, 7 to 10 tons per acre being secured. Irish potatoes and alfalfa give good returns, and the soil seems best adapted to these products, and probably could be used to advantage for truck. Some wild hay is harvested from the wetter areas, the yield ranging from one-half to three-fourths ton per acre.

	1	2	3	4
Soil (1)	4	70	16	9
Subsoil (1)	5	69	19	6

	Acres.
Stanton, Nebr	22,144

Arkansas loam.—This type consists of a very dark brown loam, fine grained and mellow, about 10 inches in depth. In poorly drained spots it is inclined to be somewhat heavy and sticky, while in areas where it lies in close proximity to the dunes of the Arkansas River it is frequently modified by wind-blown sand and has somewhat of the nature of a sandy loam. The subsoil is composed of a grayish-brown mixture of clay and silt, resting on interstratified layers of sand, medium to fine in texture, and clay. The latter is somewhat calcareous, or contains small concretions of lime. The soil is alluvial in origin, and the surface is flat. It is elevated from 6 to 15 feet above the streams, and a part of it is subject to almost annual inundation. Nearly all the ordinary farm crops are grown. The soil is particularly well adapted to alfalfa. Potatoes and other vegetables do well. Grapes and other fruits are grown with profit.

	1	2	3	4
Soil (3)	4	29	54	13
Subsoil (2)	3	21	50	26

	Acres.
Wichita, Kans	45,568

Lintonia loam.—Brown silty loam, 0 to 9 inches; yellow silt, 9 to 36 inches, underlain by drab clay at a depth of 3 or 4 feet. Slope in front of bluff. Rarely inundated, but subject to addition of material from bluff during winter rains. Cotton produces well. Adapted also to market gardening and fruit culture. In northern areas good yields of corn, wheat, oats, hay, and potatoes.

	1	2	3	4
Soil (10)	2	16	71	11
Subsoil (8)	3	14	69	14

	Acres.		Acres.
Dubuque, Iowa	22,272	Tazewell County, Ill	29,056
St. Clair County, Ill	5,696	Yazoo, Miss	3,060
Smedes, Miss	10,368		

Kaskaskia loam.—Surface soil consists of a heavy brown loam 9 inches deep, containing much silt. The subsoil is a mottled gray and yellow silty loam or silty clay. Occupies low alluvial bottoms; subject to overflow; often poorly drained. Derived from alluvial sediments. Corn and hay principal crops.

	1	2	3	4
Soil (10)	2	10	61	27
Subsoil (10)	3	11	61	26

	Acres.		Acres.
Clinton County, Ill	24,576	Sangamon County, Ill	40,192
Knox County, Ill	29,148	St. Clair County, Ill	9,664
McLean County, Ill	20,352		

Sharkey clay.—Soil is a stiff, waxy clay, 8 inches deep, varying in color from black to light chocolate brown, and containing lime and iron concretions. Subsoil is a stiff, impervious clay, similar to soil. Surface sun-cracks readily. Locally known as "buckshot" land. A poorly drained soil occupying lowest portions of river bottoms. Subject to overflow annually. When diked and well drained it is a strong soil, suited to corn, sugar cane, and cotton.

	1	2	3	4
Soil (22)	2	9	41	48
Subsoil (22)	1	6	39	53

	Acres.		Acres.
Brazoria, Tex	133,056	Parsons, Kans	31,808
Miller County, Ark	110,656	Smedes, Miss	149,440
New Orleans, La	157,952	Union County, Ky	4,032
Ouachita, La	67,264	Yazoo, Miss	184,380
Paris, Tex	19,136		

PIEDMONT PLATEAU SOILS.

The soils of the Piedmont Plateau are derived almost exclusively from the disintegration of igneous or metamorphic rocks, the materials of which have been further modified by local erosion and stream action. The characteristic soil of the region is the Cecil clay, a heavy but friable red clay, extending from New Jersey to Georgia and forming the soil or the subsoil over much of the area

of the plateau. The surface of the plateau has been very much cut by stream action, giving a very rolling and in places a hilly character to the country. A peculiar characteristic of the soils is that they are composed either of coarse sand or of heavy clay, very few soils of intermediate texture being found. The lighter soils are but poorly adapted to general farm crops, but on account of their ease of cultivation and the light draft animals and general conditions of labor are usually preferred to the clay soils. The latter, especially the Cecil clay, are adapted to corn, wheat, and grass, but are more difficult to cultivate, and during the hot summers, with indifferent cultivation, crops are often poor in quality and low in yields. The Cecil clay when well cultivated, as it is in New Jersey, Pennsylvania, and Maryland, appears like a different soil from the raw, gullied areas in many portions of the Southern States.

CECIL SERIES.

Cecil stony loam.—Soil derived from the weathering of igneous and metamorphic rocks and of intrusive dikes of fine-grained trap (diabase). Soil is a red loam about 12 inches deep, mixed with from 30 to 60 per cent of stones and bowlders. Subsoil is a heavy red clay or clay loam, also containing rock fragments. This type produces good general farm crops when cleared of stones.

	1	2	3	4
Soil (4)	21	32	29	15
Subsoil (4)	12	28	24	34

	Acres.
Campobello, S. C	1,805
Lancaster County, Pa	[a] 4,900
Lebanon, Pa	22,500

Cecil sand.[b]—Coarse sand, rather loamy in character, about 6 inches deep, underlain with material of the same kind but of lighter color, and this in turn underlain at from 18 to 22 inches with a yellow sandy clay. Residual soil derived from granite, gneiss, and mica schist. Usually from 10 to 30 per cent of quartz and

[a] Part mapped as Hempfield stony loam and part as Manor stony loam, neither of which names will again be used.

[b] Mapped as Durham sandy loam, which name will not be used hereafter.

rock fragments in both soil and subsoil. Good for cotton. Fair soil for corn, but giving low yields. Fairly good for truck, especially sweet potatoes and watermelons, and has been used to considerable extent for bright tobacco.

	1	2	3	4
Soil (16)	34	41	16	7
Subsoil (16)	22	28	16	31

	Acres.		Acres.
Abbeville, S. C	27,840	Hickory, N. C	7,360
Alamance County, N. C	84,900	Prince Edward, Va	20,710
Campobello, S. C	2,086	Raleigh to Newbern, N. C	20,950
Cary, N. C	8,090	Statesville, N. C	10,560

Cecil sandy loam.—Soil is a sandy loam of a brownish or yellowish color, 6 to 15 inches deep; subsoil is a clay of reddish or yellowish color, containing coarse sand, both soil and subsoil containing fragments of quartz. There is usually considerable quartz on the surface. High, rolling land of Piedmont Plateau. Derived from granite, gneiss, and other metamorphosed rocks. Corn and cotton soil of the southern Piedmont. Is used for both bright and dark shipping tobacco in Virginia. Lightest desirable soil for general farming purposes.

	1	2	3	4
Soil (24)	33	37	19	11
Subsoil (24)	17	17	19	42

	Acres.		Acres.
Abbeville, S. C	236,288	Covington, Ga	27,500
Albemarle, Va	47,808	Hickory, N. C	355,968
Bedford, Va	33,740	Prince Edward, Va	91,710
Campobello, S. C	85,888	Raleigh to Newbern, N. C	15,560
Cary, N. C	26,090	Statesville, N. C	148,910
Cobb County, Ga	23,170		

Cecil loam.—Soil is a loam, or heavy sandy loam, of brown or yellow color, 10 inches deep; heavy loam or clay loam subsoil of reddish color, both soil and subsoil containing fragments of quartz, with usually considerable quartz on the surface. High, rolling land. Derived from granite, gneiss, and other metamorphosed rocks. Recognized as good soil for general farming purposes, but requires careful treatment. Adapted to wheat, corn, and grass. Used extensively for tomatoes.

	1	2	3	4
Soil (12)	12	20	44	22
Subsoil (12)	12	19	42	26

	Acres.		Acres.
Albemarle, Va	94,592	Leesburg, Va	89,600
Cecil County, Md	52,600	Trenton, N. J	13,952
Harford County, Md	110,320		

Cecil mica loam.—Loose brown loam, 12 inches deep, underlain by clay loam, both soil and subsoil consisting largely of small fragments of muscovite mica, which makes them soft and almost incoherent. Rolling land of Piedmont Plateau. Derived from decomposition of highly crystalline rocks; typically developed in Cecil County, Md., and Lancaster County, Pa. Recognized as good land for general farming purposes.

	1	2	3	4
Soil (8)	15	34	30	18
Subsoil (8)	22	33	26	16

	Acres.		Acres.
Cecil County, Md	10,000	Leesburg, Va	4,608
Harford County, Md	39,930	Prince George County, Md	600
Lancaster County, Pa	10,000		

Cecil silt loam.—Light yellowish-gray to white silt loam, 8 to 10 inches deep, frequently containing from 10 to 30 per cent of rock fragments. The subsoil is a light yellow to red clay, becoming heavier with depth. Occupies high, rolling areas. Derived from highly metamorphosed crystalline rocks. Drainage is generally good. Frequently considerably eroded. Fair to poor soil for cotton, corn, and wheat.

	1	2	3	4
Soil (4)	6	11	64	17
Subsoil (4)	4	9	52	32

	Acres.
Alamance County, N. C	[a]7,860
Leesburg, Va	4,928

Cecil clay.—Clay soil of reddish color, 6 inches deep; stiff tenacious clay subsoil, of red color, both soil and subsoil containing quartz and fragments of undecomposed rock. Occasional rock areas and isolated bowlders or "niggerheads." High, rolling land. Derived from gabbro and other eruptive rocks. Occurs in the Piedmont Plateau. Recognized as strongest soil of this region for general farming purposes. Adapted to grass, wheat, and corn in

[a] Mapped as Alamance silt loam, which name will not be used hereafter.

Maryland and Pennsylvania; export tobacco and wheat in Virginia; and to corn, wheat, and cotton in the Carolinas.

	1	2	3	4
Soil (38)	16	26	27	26
Subsoil (39)	10	17	25	43

	Acres.		Acres.
Abbeville, S. C	332,992	Covington, Ga	99,930
Albemarle, Va	79,680	Harford County, Md	39,890
Alamance County, N. C	101,370	Hickory, N. C	120,704
Bedford, Va	142,730	Leesburg, Va	32,000
Campobello, S. C	187,443	Prince Edward, Va	31,590
Cary, N. C	2,960	Raleigh to Newbern, N. C	2,030
Cecil County, Md	12,500	Statesville, N. C	289,590
Cobb County, Ga	166,130		

PENN SERIES.

The Penn series is derived from the disintegration of dark-red sandstone or shale. In productiveness and latitude of crop adaptation the Penn series may be considered as somewhat below the Hagerstown series and above the Cecil series for soils of corresponding texture.

Penn stony loam.—Very stony land, hilly to mountainous in character, and generally covered with a natural forest of chestnut and oak. It consists of a rather heavy Indian-red loam, 8 to 10 inches deep, containing from 30 to 60 per cent of red or brown sandstone fragments. The subsoil is of much the same character to a great depth. This type is derived from the more siliceous or hardened phase of the Triassic sandstone. It is well adapted to forestry and orcharding, and the more level areas, when the stones are removed, to general farm crops.

	1	2	3	4
Soil (9)	13	26	38	23
Subsoil (12)	17	31	29	22

	Acres.		Acres.
Connecticut Valley, Connecticut and Massachusetts	[a]71,936	Leesburg, Va	1,280
Lebanon, Pa	49,160	Lockhaven, Pa	6,080
		Trenton, N. J	5,632

[a] Mapped as Triassic stony loam, which name will not be used hereafter outside the Connecticut Valley.

Penn gravelly loam.—A dark-red or brown sandy loam, 8 to 10 inches deep, of medium texture, containing from 10 to 60 per cent of small, rounded sandstone gravel. The subsoil is a dark Indian-red loam or clay loam. Occurs as high, rolling upland. The drainage is good, but the soil is inclined to wash badly. Derived generally from the Triassic red sandstone. Produces fair yields of corn, wheat, vegetables, and small fruit.

	1	2	3	4
Soil (2)	16	38	27	20
Subsoil (2)	16	26	35	23

	Acres.
Leesburg, Va	704

Penn sandy loam.—Soil sandy loam, 6 to 15 inches deep, underlain by heavier loam or clay loam, usually Indian-red or brown in color; sandstone fragments to the extent of 5 to 20 per cent generally present. It is derived from the Triassic red sandstone. The surface varies from rolling to moderately hilly land. It is easily tilled. Crops are of good quality, but light yield.

	1	2	3	4
Soil (6)	26	35	23	15
Subsoil (4)	27	23	23	26

	Acres.		Acres.
Albemarle, Va	5,568	Lebanon, Pa	40,590
Fort Payne, Ala	576	Trenton, N. J	10,816

Penn loam.—Is a dark Indian-red loam, 8 to 12 inches deep, underlain by Indian-red clay loam subsoil. Occasionally contains 5 to 20 per cent of sandstone fragments. Surface gently rolling. Derived from fine-grained brown or red sandstone (Triassic). The drainage is fair, but plowing in beds is generally practiced to assist the natural drainage. It is considered almost equal to associated limestone soils in fertility.

	1	2	3	4
Soil (9)	12	20	47	22
Subsoil (9)	12	19	45	27

	Acres.
Lebanon, Pa	26,890
Leesburg, Va	18,880
Trenton, N. J	171,712

Penn clay.—A dark Indian-red to dark reddish brown heavy clay about 8 inches deep. Subsoil a dark Indian-red clay, grading into a stiffer clay. Occupies gently rolling upland as a series of low ridges. Drainage good. Of residual origin from Triassic red sandstone and shale. Wheat, corn, and grass are principal crops.

	1	2	3	4
Soil (7)	8	20	32	40
Subsoil (7)	8	15	27	49

	Acres.
Albemarle, Va	16,128
Leesburg, Va	11,776
Syracuse, N. Y	3,840

MISCELLANEOUS SOILS OF THE PIEDMONT PLATEAU.

Loudoun sandy loam.—A heavy brown or gray sandy loam 8 to 10 inches deep, underlain by a heavy yellow or red loam or clay loam. There is a considerable variation in the subsoil, coarse sand often forming so large a proportion as to give it almost the texture of the soil. The surface material is not a loose sandy loam, but has the properties of a loam, containing, however, considerable quantities of coarse quartz fragments. The soil resembles in some respects the Cecil sandy loam and Cecil loam with which it is associated. Occurs in rolling and somewhat hilly areas, generally well drained. Derived from the weathering of a coarse-textured schist and an eruptive crystalline granite, the original rock containing a large amount of feldspar. Good soil for corn, yielding from 40 to 50 bushels per acre. It is too little retentive of moisture for wheat, which produces only from 10 to 15 bushels. It is a fairly good soil for grass and clover.

	1	2	3	4
Soil (3)	32	24	25	20
Subsoil (3)	25	21	25	29

	Acres.
Leesburg, Va	27,968

Worsham sandy loam.—Gray sandy loam, generally fine, and of soft, whitish appearance, having a depth of 12 to 14 inches. Subsoil yellowish, sticky, sandy loam or loam to a stiff, plastic, yellow clay, mottled with white. Residual origin from granites,

gneisses, and schists. Originally post-oak land. Clover, grasses, hay, and pasturage.

	1	2	3	4
Soil (2)	20	43	29	7
Subsoil (2)	14	26	24	34

	Acres.
Prince Edward, Va	8,520

Cardiff slate loam.—Heavy yellowish-brown loam, having a depth of 8 or 10 inches, underlain by heavy yellow silty clay to a depth of 3 feet or more. Both soil and subsoil contain from 15 to 40 per cent of partially decomposed slate fragments. Formation occurs on prominent narrow ridges. Derived from the decomposition and breaking up of fine-grained slate. The presence of the slate fragments in the soil makes quite friable what would otherwise be a refractory clay. Much of the area is forested with oak, chestnut, and other trees. Produces fair crops of corn, wheat, rye, oats, and grass.

	1	2	3	4
Soil (1)	3	4	56	31
Subsoil (1)	5	7	53	29

	Acres.
Harford County, Md	1,690

Conowingo barrens.—Loam 3 feet or more in depth, frequently filled with fragments of broken rock, increasing in size and amount in lower depths; often there is no soil covering over the broken fragments of rock. Rolling upland of Piedmont Plateau. Derived from decomposition of serpentine and rocks of similar nature. Generally unproductive and frequently worthless for agricultural purposes, owing to slight depth of soil covering, but usually ascribed to preponderance of magnesia.

	1	2	3	4
Soil (2)	8	16	50	23
Subsoil (2)	6	14	54	23

	Acres.
Albemarle, Va	6,976
Cecil County, Md	2,000
Harford County, Md	3,280

Conowingo clay.—Heavy loam or red clay, 3 feet or more in depth. High, rolling land of Piedmont Plateau. Derived from decomposition of serpentine, steatite, and similar rocks; typically

developed in Cecil County, Md. Generally strong and productive soil for general agricultural purposes. The difference in texture and agricultural value between this type and the Conowingo barrens has never been satisfactorily explained.

	1	2	3	4
Soil (7)	19	23	35	21
Subsoil (7)	20	17	28	32

	Acres.		Acres.
Albemarle, Va	6,272	Harford County, Md	6,510
Cecil County, Md	3,000	Hickory, N. C	29,952

Davie clay loam.—Pale-yellow loam 6 inches in depth, underlain by pale-yellow friable clay which becomes red and heavier in texture in lower depths. Soil and subsoil contain small amounts of broken quartz fragments. Level or gently rolling uplands. Derived from decomposition of talc schists and similar rocks. Area mostly forested. Produces poor crops of wheat, corn, and tobacco.

	1	2	3	4
Soil (4)	7	40	37	14
Subsoil (3)	3	24	29	42

	Acres.
Abbeville, S. C	25,856
Statesville, N. C	3,370

Iredell clay loam.—Dark-brown loam 8 inches deep, containing small rounded iron concretions on the surface. Subsoil is stiff, impervious yellow clay 24 inches deep, underlain by soft decomposed rock. Level or slightly rolling areas. Residual soil derived from diorite and similar eruptive rocks. Known as "black-jack" or "beeswax" land, the latter term being suggestive of the character of the subsoil. In level areas inclined to be swampy on account of impervious nature of clay subsoil. Considered poor cotton, corn, and wheat land.

	1	2	3	4
Soil (10)	18	37	35	12
Subsoil (10)	6	18	27	45

	Acres.		Acres.
Abbeville, S. C	14,848	Prince Edward, Va	103,070
Alamance County, N. C	18,760	Statesville, N. C	22,340
Leesburg, Va	18,048		

APPALACHIAN MOUNTAIN AND CUMBERLAND PLATEAU SOILS.

Two large series have been encountered in the Appalachian Mountain and Cumberland Plateau, viz, the Porters series, derived from igneous rocks, and the De Kalb series, derived from sandstone and shales. The Porters series is analagous in every way, except in physiographic position, to the Cecil series of the Piedmont Plateau. The mountainous character of the country in which these soils are found renders them difficult of cultivation, and the cultivated fields are small in extent. The soils are also at a much higher elevation, and so are influenced more or less by different climatic conditions. On the more level and less elevated areas wheat, corn, rye, and barley, and some fruit, particularly apples, are produced. At a medium elevation and under suitable conditions of slope and exposure fruit is the principal crop. Grazing of cattle is one of the most important industries. The soils seem eminently adapted to fruit culture, and this industry is rapidly extending and is destined to take on much larger proportions.

PORTERS SERIES.

Porters stony loam.—Grayish-yellow sandy loam, 10 inches deep, mixed with fragments of sandstone and other rocks. Subsoil grades from reddish-brown clay loam to a stiff red clay in lower depths, and contains some coarse sand and a large percentage of sandstone fragments. Rolling valley lands and gentle slopes of mountains. Soil is colluvial, derived from wash from mountains, but subsoil is derived from decomposition of underlying rocks. Produces good crops—wheat, corn, grass, tobacco, rye, and apples.

	1	2	3	4
Soil (9)	25	30	29	14
Subsoil (7)	17	25	27	26

	Acres.		Acres.
Alamance County, N. C	a4,960	Hickory, N. C	25,152
Cobb County, Ga	a2,020	Statesville, N. C	8,130

Porters sand.—Grayish-yellow coarse sand, 10 inches in depth, overlying coarse sand and masses of broken rock. Fragments of rock and huge bowlders scattered on the surface. Occupies

a Mapped as Herndon stony loam, which name will not hereafter be used.

mountain slopes. Is derived from weathering of granite, gneiss, and similar rocks. Where slopes are not steep, used to some extent for general farming. Formerly bright tobacco was grown. Adapted to peach and grape culture.

	1	2	3	4
Soil (11)	41	34	14	12
Subsoil (11)	48	33	10	8

	Acres.		Acres.
Albemarle, Va	115,136	Hickory, N. C	11,264
Asheville, N. C	13,056	Mount Mitchell, N. C	42,816
Campobello, S. C	15,238		

Porters sandy loam.—A grayish-yellow sandy loam, 6 to 15 inches deep. The subsoil is a tenacious red clay. Both soil and subsoil contain fragments of quartz and other rocks. Occupies mountain or high, rolling lands. A residual soil from igneous rocks. Wheat, corn, oats, rye, potatoes, and fruit are the principal crops.

	1	2	3	4
Soil (19)	30	34	23	13
Subsoil (19)	24	29	24	23

	Acres.		Acres.
Asheville, N. C	41,792	Mount Mitchell, N. C	76,480
Bedford, Va	46,150	Hickory, N. C	49,792
Campobello, S. C	13,267		

Porters loam.—A dark-red or gray loam, 6 to 15 inches deep. Subsoil is a tenacious red clay. Both soil and subsoil contain fragments of quartz and other rocks. Occupies mountain or high, rolling lands. Derived from igneous rocks. Wheat, corn, oats, rye, potatoes, and fruit are the principal crops.

	1	2	3	4
Soil (3)	22	29	24	25
Subsoil (3)	16	21	20	44

	Acres.
Asheville, N. C	180,416

Porters black loam.—Rich, dark loam, 15 inches deep, mixed with rounded and angular fragments of rock, often several feet in diameter. Subsoil is a yellowish-brown or reddish clay loam, containing a large percentage of rocks. Steep slopes of higher mountains. Residual soil derived from granite, gneiss, and similar rocks. Fertile soil, but slopes are too steep and stony to admit of extensive cultivation for general farm crops. Especially adapted

to apples, particularly the Albemarle pippin. For this apple the small coves on the east side of the mountains are considered most desirable. Where exposed on the top of mountains it has little value for fruit, and is used only for grazing.

	1	2	3	4
Soil (15)	22	27	25	24
Subsoil (12)	23	25	26	26

	Acres.		Acres.
Albemarle, Va	68,736	Hickory, N. C	512
Asheville, N. C	24,064	Mount Mitchell, N. C	87,808
Bedford, Va	8,270		

Porters clay.—Reddish-brown clay loam, 6 inches deep, underlain by stiff, tenacious red clay to a depth of 20 inches or more. Both soil and subsoil contain a large percentage of stone. Occupies mountain slopes. Residual soil derived from granite and other crystalline rocks. When not too stony and rough, good soil for corn, wheat, and grass. One of the important apple soils of the mountains, particularly for Winesap and similar types of apples.

	1	2	3	4
Soil (17)	17	23	27	31
Subsoil (17)	14	18	24	43

	Acres.		Acres.
Albemarle, Va	32,512	Campobello, S. C	13,005
Asheville, N. C	49,152	Leesburg, Va	2,752
Bedford, Va	[a]28,240	Mount Mitchell, N. C	106,176

DE KALB SERIES.

The De Kalb soils occur in the Appalachian Mountains and Cumberland Plateau, and are formed from the disintegration of sandstones and shales. The soils are not very productive, and, with one exception, do not seem to be adapted to any particular crop or class of crops.

De Kalb stony loam.—Gray to white sandy loam, 6 to 10 inches deep, grading into a subsoil of the same texture and color, or into red or yellow clay. Both soil and subsoil contain a large quantity of fragments of sandstone, conglomerate, and sandy calcareous shale. The soil frequently rests directly upon a broken mass of rock. The

[a] Mapped as Porters red clay, which name will not be used hereafter.

topography is very rough and broken. Owing to the physiographic position and its very stony nature, the soil is not very productive, although where the clay subsoil prevails and a part of the stones are removed fair crops are produced. The sandy and sandy loam phases with proper location and elevation are well adapted to peaches. Wheat, where grown, produces a small yield of bright, heavy grain. The native growth consists mainly of chestnut and white oak, with some hickory, black gum, and red oak.

	1	2	3	4
Soil (15)	14	33	31	22
Subsoil (14)	14	31	28	27

	Acres.		Acres.
Albemarle, Va	[a] 134,656	Lockhaven, Pa	111,872
Lancaster County, Pa	[a] 13,000	Fort Payne, Ala	37,120
Lebanon, Pa	[a] 20,300	Pikeville, Tenn	32,128
Leesburg, Va	19,072		

De Kalb sandy loam.—Gray to reddish-brown sandy loam of medium to fine texture, 9 to 12 inches deep, resting on a yellowish-brown slightly sticky sandy loam. Occurs in rather level areas. Residual in origin, derived from sandstone rock. Occasionally broken sandstone lies directly under the surface soil. Soil is easily cultivated and responds readily to fertilizers, but is not very productive. Some wheat is grown which produces not more than 7 bushels per acre on the average. The yield of corn rarely exceeds 15 or 20 bushels, while cotton gives from 200 to 350 pounds lint per acre. This soil is adapted to vegetables, and very well adapted to apples and peaches.

	1	2	3	4
Soil (6)	16	38	30	17
Subsoil (6)	15	34	29	23

	Acres.
Fort Payne, Ala	182,656
Pikeville, Tenn	163,392

De Kalb fine sandy loam.—Fine compact sandy loam, 8 to 12 inches deep, resting upon a subsoil of similar material, becoming more loamy as the depth increases. Derived from sandstone. Soil naturally not productive, and small crops are obtained unless heavily fertilized. With proper cultivation fairly well adapted to

[a] Mapped as Edgemont stony loam, which name will not hereafter be used.

fruit and truck. The principal timber so far seen is chestnut and oak.

	1	2	3	4
Soil (1)	11	52	25	12
Subsoil (1)	7	44	34	15

	Acres.
Huntsville, Ala.	2,240

De Kalb clay loam.—Yellowish-brown fine sandy or silty loam 10 to 15 inches deep, resting on a yellow clay loam subsoil. Occupies valleys and valley slopes. Wash from sandstone hills. The soil is locally termed "glades." The drainage is generally poor. Very little of the type is under cultivation. Well-drained fields produce from 30 to even 50 bushels of corn per acre. Well adapted to grass, and good yields of hay are secured. Native vegetation is a rank growth of sedge grasses.

	1	2	3	4
Soil (2)	13	20	40	27
Subsoil (2)	13	17	38	33

	Acres.
Pikeville, Tenn	17,024

MISCELLANEOUS SOILS OF THE APPALACHIAN MOUNTAINS AND CUMBERLAND PLATEAU.

Chattooga loam.—Yellowish-brown to gray sandy loam grading into a loam at about 10 inches. A heavier phase of the type occurs in the low-lying areas. The sand varies in texture from medium to fine. The subsoil contains sufficient clay to make it a heavy coherent loam. Occurs as a bottom or river terrace soil. Subject to occasional overflow. Derived in part from the weathering of shale and in part as alluvial material from the same source. Fairly productive for corn.

	1	2	3	4
Soil (2)	6	45	35	14
Subsoil (2)	4	30	39	28

	Acres.
Fort Payne, Ala	5,696

RESIDUAL LIMESTONE VALLEY AND UPLAND SOILS.

There are three important series of soils derived from limestone. The Hagerstown series is formed mainly from the solution and subsequent filtration of pure massive limestone and the

disintegration of the interbedded shale. These soils, as a rule, occur in valleys bordered by areas of the more resistant sandstones and shales. They form one of the most productive series of soils in the United States for the general farm crops. These soils are liable to be encountered in small areas in the Piedmont Plateau, and occupy very extensive areas of rolling country in middle Kentucky and Tennessee. The most productive valley phase occurs in the large valley between the Blue Ridge and the Allegheny mountains.

The Fort Payne series is derived mainly from the disintegration of magnesium limestone (dolomite), which is usually very impure and cherty. This gives rise to a very rough and even mountainous topography, with generally stony soils. In productiveness this series is far below the Hagerstown series.

The Clarksville series, derived mainly from the St. Louis group of the sub-Carboniferous, occupies both level upland areas and rough, hilly country. Soils with the latter surface features are generally unproductive and very stony, but admirably adapted to fruit, especially to apples. The soil types in this series occupying level or gently rolling areas, formed from a less impure limestone, are as a rule very productive and adapted to wheat, corn, and tobacco.

HAGERSTOWN SERIES.

Hagerstown stony loam.—A fine sandy loam to fine loam, 8 inches deep, brown or light-gray to yellowish in color. Subsoil a yellowish-red clay loam to a stiff red clay. Soil and subsoil contain angular fragments of cherty material. Occupies valleys and rolling uplands. Drainage good. Derived from weathering of impure or cherty veins in areas of pure massive limestone. Wheat and corn principal crops, of which small yields are obtained. Best adapted to fruit, especially apples.

	1	2	3	4
Soil (9)	7	15	50	28
Subsoil (9)	5	11	38	46

	Acres.		Acres.
Albemarle, Va	59,136	Lockhaven, Pa	22,016
Bedford, Va	[a]11,950	Pikeville, Tenn	27,392
Huntsville, Ala	41,984		

[a] Mapped as Murrill stony loam, which name will not be used hereafter.

Hagerstown sandy loam.—A fine sandy loam, about 12 inches deep, of a gray to yellowish or light-brown color. Subsoil a yellowish-red clay, grading into a stiff red clay. Occupies some of the higher ridges of the valley. Good drainage. Of residual and colluvial origin from limestone débris. Wheat, corn, and grass are grown. Adapted to fruit, particularly peaches.

	1	2	3	4
Soil (10)	15	39	32	13
Subsoil (10)	8	23	31	38

	Acres.		Acres.
Albemarle, Va	65,504	Leesburg, Va	1,216
Bedford, Va	[a]11,910	Pikeville, Tenn	5,760
Huntsville, Ala	8,064		

Hagerstown loam.—Brown or yellow loam 12 inches deep, yellow clay loam to 24 inches, underlain by stiff, tenacious red clay. Rolling valley land and uplands. Derived from weathering of pure massive limestone. Typical corn land of central Pennsylvania, Maryland, and the Shenandoah Valley, of Virginia. One of the best types of general farming lands in the Eastern States. Produces corn, tobacco, wheat, and grass.

	1	2	3	4
Soil (29)	6	14	51	27
Subsoil (29)	6	12	42	37

	Acres.		Acres.
Albemarle, Va	30,784	Lebanon, Pa	93,110
Bedford, Va	40,520	Leesburg, Va	4,864
Davidson County, Tenn	123,264	Mason County, Ky	24,284
Fort Payne, Ala	21,632	Pikeville, Tenn	20,352
Huntsville, Ala	138,944	Scott County, Ky	76,800
Lancaster County, Pa	45,000		

Hagerstown silt loam.—The soil is a yellowish-gray silty loam from 8 to 10 inches deep, resting on a stratum of yellow clay loam from 6 to 12 inches thick, which is in turn underlain by a yellow clay. At a depth of 3 to 10 feet a stiff red clay is found. Throughout the soil and subsoil, over probably 50 per cent of the area, occur varying proportions of gravel and small fragments of chert and cherty limestone. In its virgin condition the soil has a greasy feel and is quite loamy, but after cultivation the texture becomes

[a] Mapped as Murrill sandy loam, which name will not be used hereafter.

that of a heavy sandy loam. It is seldom that the stones in the soil are numerous enough to interfere with cultivation. The surface is, on the whole, flat or gently rolling. The soil is known locally as the "barrens." It varies considerably in productiveness, but at best the yields are low. Corn gives from 10 to 15 bushels, and cotton about one-fourth bale per acre. Truck and fruit are also grown to some extent.

	1	2	3	4
Soil (3)	3	15	63	18
Subsoil (3)	7	15	56	22

	Acres.
Huntsville, Ala	59,520

Hagerstown shale loam.—Loam 12 inches deep, containing 20 to 60 per cent of fragments of shale, resting upon a mass of broken shale. Ridges in limestone valley. Thin, dry soil, derived from disintegration of shales, requiring very thorough cultivation, but when so cultivated adapted fairly well to general agricultural purposes.

	1	2	3	4
Soil (17)	14	13	42	28
Subsoil (10)	13	13	41	31

	Acres.		Acres.
Albemarle, Va	75,328	Lebanon, Pa	142,210
Bedford, Va	25,370	Leesburg, Va	8,000
Bigflats, N. Y	108,800	Lockhaven, Pa	25,728
Lancaster County, Pa	15,000		

Hagerstown clay loam.—Heavy reddish clay, 24 inches deep, overlying stiff, tenacious red clay. Rolling valley land. Derived from weathering of pure massive limestone. Recognized as one of the strongest soils for general agricultural purposes. Well known for large crops of wheat and corn.

	1	2	3	4
Soil (2)	6	12	63	15
Subsoil (3)	6	13	49	26

	Acres.
Lancaster County, Pa	21,000

Hagerstown clay.—Heavy red loam or clay 12 inches deep, underlain by stiff, tenacious red clay. Rolling valley land. Derived

from weathering of pure massive limestone. Recognized as one of the strongest soils for general agricultural purposes.

	1	2	3	4
Soil (28)	4	13	51	31
Subsoil (21)	3	10	39	47

	Acres.		Acres.
Albemarle, Va	25,920	Lancaster County, Pa	2,000
Bedford, Va	19,210	Leesburg, Va	4,224
Fort Payne, Ala	3,968	Mason County, Ky	115,648
Huntsville, Ala	9,024	Scott County, Ky	102,528

SOILS ASSOCIATED WITH THE HAGERSTOWN SERIES.

Dauphin sandy loam.—Sandy shale loam, 6 to 15 inches deep, underlain by the same material slightly heavier. It is derived from a formation consisting of alternate beds, each 6 inches or more in thickness, of sandstone and shale. It is easily tilled, and is adapted to a wide range of crops, as well as possessing qualities suited for certain kinds of trucking and the growing of wrapper-leaf tobacco.

	1	2	3	4
Soil (2)	18	29	30	19
Subsoil (2)	33	25	26	19

	Acres.
Lebanon, Pa	11,220

Cumberland loam.—A brown, rather mellow loam, 6 to 15 inches in depth, underlain by a brown to reddish-brown silty clay subsoil. Some rounded gravel occurs in both soil and subsoil. Occupies second bottoms along the Cumberland River, occurring mainly in the horseshoe bends. The surface is generally rolling and the drainage is excellent, the soil retaining enough moisture to resist to a marked extent the effects of drought. An older sedimentary soil made up of materials washed from the adjacent uplands intermingled with materials brought by the river from greater distance. The type has a wide crop adaptation. It produces well the general farm crops, while also used for truck crops and small and orchard fruits. Corn yields from 20 to 40 bushels, wheat 15 to 25 bushels, and hay 1 to 1½ tons per acre.

	1	2	3	4
Soil (2)	8	40	37	15
Subsoil (2)	6	29	37	30

	Acres.
Davidson County, Tenn	44,992

Davidson loam.—A brown to reddish-brown silty loam, underlain by a brown or reddish-brown silty clay subsoil. Both soil and subsoil usually contain from 5 to 20 per cent of limestone fragments and smaller particles of siliceous rock, the former about 1½ inches in diameter. The soil is usually considerably lighter than the Hagerstown loam, and the subsoil is rather more friable and porous. The surface is gently rolling, and naturally well-drained by many small streams, flowing in channels not deeply eroded. The subsoil is fairly retentive of moisture. The type is derived from blue fossiliferous limestone, in which is interbedded a siliceous rock, having in some instances the character of sandstone. Not quite so productive a soil as the Hagerstown loam, but ranks high in the production of corn, sweet and Irish potatoes, melons, and small and orchard fruits. It is also a good soil for hay and forage crops.

	1	2	3	4
Soil (2)	4	26	51	20
Subsoil (2)	5	22	43	30

	Acres.
Davidson County, Tenn	39,936

Conestoga loam.—Brown loam, 12 inches deep, underlain by light clay loam to depth of 30 inches, grading into decomposed schist. Rolling valley land. Derived from decomposition of limestone schist; has a greasy or soapy feel when rubbed between the fingers. Recognized as one of the best soils for general agricultural purposes.

	1	2	3	4
Soil (2)	6	30	50	11
Subsoil (2)	5	34	45	13

	Acres.
Lancaster County, Pa	51,000

Lickdale clay loam.—Is a silty loam, 6 to 10 inches in depth, underlain by a mottled yellow clay. It occurs in small extent at the foot of the Blue Ridge Mountains, and is derived from the wash of the mountains and the adjacent shale formations. Sometimes fragments of gray sandstones are present to the extent of from 5 to 20 per cent. It is low lying, flat land, and poorly drained. Naturally it is very refractory, and is suited only to grass and

pasture, but when artificially drained it becomes mellow and produces quite a wide range of crops.

	1	2	3	4
Soil (3)	6	11	52	24
Subsoil (3)	5	7	38	48

	Acres.
Lebanan, Pa	3,920
Lockhaven, Pa	1,984

Murrill clay loam.—Yellowish-brown clay loam, 10 inches deep, overlying yellow clay loam, increasing in clay content in lower depths. Both soil and subsoil often contain small fragments of shale and chert. Derived from weathering of shales and cherty limestone. Rolling valley lands. Fertile soil; produces good crops of wheat, corn, grass, dark manufacturing tobacco, and apples.

	1	2	3	4
Soil (3)	13	15	42	27
Subsoil (3)	12	11	30	43

	Acres.
Bedford, Va	15,720

Conestoga clay.—A yellowish to dark-brown clay loam, about 7 inches deep, underlain by a yellow to reddish-yellow tenacious clay, usually not exceeding a depth of 24 inches. On ridges the rock is usually found at an average depth of 10 inches. Occupies the lower and gently rolling portions of the valleys. Higher areas well drained. Of residual origin from limestone schist. Wheat and grass principal crops.

	1	2	3	4
Soil (4)	9	7	43	41
Subsoil (3)	7	5	37	51

	Acres.
Albemarle, Va	16,960

FORT PAYNE SERIES.

Fort Payne stony loam.—The surface soil is a gray to light-brown silty loam, 10 to 14 inches deep, containing a high percentage of chert. The subsoil—a much heavier yellowish-red loam or clay—also contains quantities of chert fragments. The surface is strewn with from 30 to 50 per cent of the same rock fragments. Occupies

very broken country, consisting of hills, ridges, and intervening valleys. Owing to the stony character of this soil and the unfavorable surface features, but little of it is under cultivation. On steep slopes erosion does much damage, and only on the more level areas can the cultivation of the type be recommended. The soil is derived from the Knox dolomite, a limestone rock containing a large quantity of difficultly soluble material known as chert. The native growth is Spanish and black-jack oak, pine, and chestnut. Cotton, corn, and some wheat are grown, but the yields are light. The soil is best adapted to fruit, and especially to peaches.

	1	2	3	4
Soil (3)	13	15	43	29
Subsoil (3)	10	14	43	33

	Acres.
Fort Payne, Ala	68,864

CLARKSVILLE SERIES.

Clarksville stony loam.—Light-yellow silty loam 6 inches in depth, overlying heavy yellowish-red clay 3 feet or more in depth. Both soil and subsoil contain 20 to 50 per cent of angular fragments of chert. Rough, broken country, with deep-cut, narrow valleys. Residual soil derived from cherty limestone. High, well-drained country, originally heavily forested with oak and chestnut. Soils are thin and stony and of little general agricultural value, and at present largely covered with thick second growth of oak timber. Adapted to apples and peaches.

	1	2	3	4
Soil (13)	5	14	65	16
Subsoil (14)	5	13	51	30

	Acres.		Acres.
Clarksville, Tenn	66,150	Howell County, Mo	499,264
Davidson County, Tenn	99,840	Wichita, Kans	4,352
Dubuque, Iowa	60,672		

Clarksville loam.—Rich, dark-brown silty loam 12 inches deep, underlain by brown loam, heavier in texture, to a depth of 3 to 6 or more feet. Occurs as well-marked bottom lands along rivers and their larger tributaries. Generally well drained, but subject to occasional overflow. Alluvial deposit laid down by rivers along

which it occurs. Fine land for corn and hay, but at present little used for other crops.

	1	2	3	4
Soil (9)	2	16	56	25
Subsoil (9)	2	13	50	34

	Acres.		Acres.
Clarksville, Tenn	17,090	Howell County, Mo	48,512
Davidson County, Tenn	12,864	Pikeville, Tenn	1,280
Fort Payne, Ala	4,992		

Clarksville silt loam.—Yellowish-gray silt loam 7 inches in depth, underlain by brownish-yellow, heavy silt loam to a depth of 24 inches, overlying heavy red clay loam 3 feet or more in depth. Deep subsoil often contains fragments of chert. Residual soil derived from limestone, or loess covering over limestone. Well drained. Naturally strong, fertile soil, but needs careful treatment to maintain fertility. Well adapted to corn, wheat, and grass.

	1	2	3	4
Soil (4)	4	9	69	16
Subsoil (4)	4	9	57	27

	Acres.
Clarksville, Tenn	233,410
Howell County, Mo	40,384

Clarksville clay loam.—Heavy reddish-brown loam 8 inches deep, underlain by heavy red clay loam to depth of 3 feet or more, clay content increasing at lower depths. Typically developed in northern portion of Montgomery County, Tenn., along Kentucky boundary line. Gently undulating country, usually well drained. Deep residual soil derived from decomposition of limestone. On account of scarcity of timber at time of discovery has always been known as the "Barrens." Strong, fertile soil, considered best general farm land of the locality. Tobacco of the export variety produces heavy yield, but not a superior quality of leaf.

	1	2	3	4
Soil (2)	2	6	72	16
Subsoil (2)	6	5	66	25

	Acres.
Clarksville, Tenn	27,460

Clarksville clay.—A heavy brown or brownish-gray loam, with a depth of 12 inches, resting on a drab or yellowish-drab clay

loam or clay. Occurs on river terraces from 20 to 30 feet above water level. Some depressed areas contain sloughs and ponds, but the greater part is well drained and under cultivation. Still subject to inundation during winter and spring. The type is a fine corn soil, producing from 40 to 60 bushels. Some cotton is grown, the yields varying from one-half bale to 1 bale per acre, but the soil is too late and cold for the best results with this crop. From 1 to 2 tons of hay are cut on some areas of this type. The native growth is oak, gum, and hickory.

	1	2	3	4
Soil (3)	1	7	56	36
Subsoil (3)	2	7	46	44

	Acres.
Huntsville, Ala	11,840

SOIL ASSOCIATED WITH THE CLARKSVILLE SERIES.

Guthrie clay.—Soil is a light-gray or grayish-white, fine silty loam having a depth of 7 inches, underlain by a heavy silty clay, plastic and impervious. The subsoil varies in color from a gray to drab, mottled with yellowish iron stains. Occupies low, flat areas on the uplands. Soil is derived from decomposition of limestone. On account of low, wet condition it is of little agricultural value unless thoroughly drained. In favorable seasons some corn and tobacco are grown. Area largely covered by hickory, sweet gum, and oak. Land generally referred to as "crawfishy."

	1	2	3	4
Soil (9)	2	11	65	21
Subsoil (9)	2	9	58	30

	Acres.		Acres.
Clarksville, Tenn	5,800	Posey County, Ind	14,592
Huntsville, Ala	10,048	Stuttgart, Ark	27,904

GLACIAL AND LOESSIAL SOILS.

Under this head will be included all soils derived directly from glacial material and from loess, occurring generally in the Ohio and Mississippi basin, in the New England States, and in the glacial portions of New York, Pennsylvania, and New Jersey. There are four or five great series of soils of very uniform character and quite a large number of soils of local origin which can not be put into any series.

MIAMI SERIES.

The Miami series is composed of light-colored glacial material, occurring on the rolling or level uplands, or in the alluvial bottoms or terraces along the streams in the glaciated area.

Miami stony loam.—Ten inches of silty loam, underlain by heavy red clay, slightly silty, to a depth of 30 inches, in turn underlain by beds of consolidated gravel. From 20 to 60 per cent of rounded and angular stones on the surface, and mixed with both soil and subsoil. Stones vary from 1 to 8 inches in diameter. Surface generally consists of large rounded hills and table-lands, and of gently rolling lands at lower levels. Chiefly derived from morainic material. Soil is very productive. Good crops of corn, wheat, grass, oats, and fruit, particularly apples, are grown. This type also affords excellent pasture.

	1	2	3	4
Soil (10)	12	26	46	16
Subsoil (11)	18	26	39	17

	Acres.		Acres.
Allegan County, Mich	[a] 76,790	Lyons, N. Y	158,400
Long Island, N. Y	52,032	Syracuse, N. Y	78,464

Miami gravel.—A medium grade sandy loam 0 to 12 inches deep, containing 50 per cent of gravel from one-half inch to 2 inches in diameter. Has a subsoil of cross-bedded sand and gravel, the latter coated with calcium carbonate. Occurs only in small areas and is the outcrop of reworked glacial gravels in river cliffs. For the most part uncultivated. Adapted to the growth of grapes and peaches. Slight value for general farming.

	1	2	3	4
Soil (2)	28	34	32	7
Subsoil (2)	33	30	27	11

	Acres.		Acres.
Janesville, Wis	[b] 9,924	Winnebago County, Ill	5,184
Tazewell County, Ill	[b] 1,088	Pontiac, Mich	[c] 6,912

Miami gravelly loam.—Brown or reddish loam, 12 inches deep, with 15 to 30 per cent of rounded gravel, underlain to a depth of 24 inches by a stiff, tenacious clay loam, which is in turn under-

[a] Mapped as Allegan stony loam, which name will not be used hereafter.
[b] Mapped as Mackinaw gravel, which name will not be used hereafter.
[c] Mapped as Allegan gravelly loam, which name will not hereafter be used.

lain by a layer of gravel. Level or gently rolling river terraces. Originally glacial material, worked over by the streams. Recognized as fine land for general farm purposes.

	1	2	3	4
Soil (10)	25	27	32	16
Subsoil (8)	27	26	28	19

	Acres.		Acres.
Allegan County, Mich	[a] 4,810	Montgomery County, Ohio	24,000
Bigflats, N. Y	15,680	Pontiac, Mich	1,088
Columbus, Ohio	18,944		

Miami sand.—Coarse to medium, loose, incoherent sand, underlain by yellow or reddish sand of about the same texture. Typical truck soil. Is the prototype of the Norfolk sand of the Atlantic coast and Fresno sand of the Pacific coast. It may be either of glacial or alluvial origin. Level or rolling in topography.

	1	2	3	4
Soil (21)	31	55	8	4
Subsoil (22)	36	55	5	4

	Acres.		Acres.
Allegan County, Mich	[b] 117,480	Posey County, Ind	7,680
Grand Island, Nebr	29,440	Toledo, Ohio	36,672
Janesville, Wis	[c] 11,648	Viroqua, Wis	28,288
Pontiac, Mich	30,592	Wichita, Kans	19,392

Miami fine sand.—A fine yellow or light-brown sand 6 to 12 inches deep. The subsoil consists of a fine orange or yellow sand. Free from stones; often occurs as dunes. Has good natural drainage, and is easily tilled. The principal crops are corn, potatoes, berries, and, of less importance, wheat, oats, grasses, and cabbages. Best adapted to truck, potatoes, and small fruit.

	1	2	3	4
Soil (20)	20	63	12	5
Subsoil (19)	19	66	10	5

	Acres.		Acres.
Dubuque, Iowa	2,624	Syracuse, N. Y	14,528
Janesville, Wis	[d] 16,256	Tazewell County, Ill	22,976
Lyons, N. Y	14,656	Wichita, Kans	15,744
Sangamon County, Ill	1,024	Winnebago County, Ill	8,832
Stanton, Nebr	56,576		

[a] Mapped as Allegan gravelly loam, which name will not hereafter be used.
[b] Mapped as Allegan sand, which name will not be used hereafter.
[c] Mapped as Hanover sand, which name will not be used hereafter.
[d] Mapped as Afton fine sandy loam, which name will not be used hereafter.

Miami sandy loam.—A light to dark-brown sandy loam 8 to 14 inches deep, underlain by a sandy loam somewhat heavier, sometimes containing some fine gravel, and underlain by gravel, but not necessarily so; either of alluvial or glacial origin; level or gently rolling; sometimes rounded hills with kettlelike intervening depressions, as well as extensive lowlands bordering water courses. In some areas adapted to corn, wheat, grass, rye, and oats; in others mainly to fruits, small fruits, and truck crops.

	1	2	3	4
Soil (16)	25	47	20	8
Subsoil (16)	23	49	19	10

	Acres.		Acres.
Allegan County, Mich	[a] 60,020	Pontiac, Mich	34,368
Dubuque, Iowa	15,040	Posey County, Ind	3,584
Grand Forks, N. Dak	68,800	Toledo, Ohio	30,528
Montgomery County, Ohio	4,000	Viroqua, Wis	16,064

Miami fine sandy loam.—Soil to the depth of 10 inches consists of chocolate-brown sandy and silty loam, underlain by a light-brown fine sand. A few stones are present on the surface and mixed with the soil. Rolling country and flat lands bordering swamps. Peaches, cherries, plums, apples, pears, and small fruit are successfully grown, as well as corn, wheat, grass, and pasture. Well adapted to truck growing.

	1	2	3	4
Soil (18)	3	48	40	9
Subsoil (17)	2	50	36	11

	Acres.		Acres.
Allegan County, Mich	[b] 13,260	St. Clair County, Ill	138,560
Bigflats, N. Y	[c] 5,632	Syracuse, N. Y	19,968
Lyons, N. Y	29,824	Union County, Ky	[d] 5,248
Posey County, Ind	3,456		

Miami loam.—A brown soil, 10 inches deep, containing a small proportion of medium to coarse sand, which in local areas grades into gravel. The subsoil, from 20 to 40 inches, is a heavy brownish-yellow loam, beneath which is found a fine gravelly

[a] Mapped as Allegan sandy loam, which name will not be used hereafter.
[b] Mapped as Allegan fine sandy loam, which name will not hereafter be used.
[c] Mapped as Elmira fine sandy loam, which name will not hereafter be used.
[d] Mapped in part as Sturgis fine sandy loam, and in part as Miami sandy loam. The former name will not be used hereafter.

loam. Occurs as terraces along rivers and as low-lying areas between sand hills. Is a fair corn soil, producing from 35 to 45 bushels. Should be used for growing canning crops, such as sugar corn, green peas, tomatoes, etc. Pears, plums, and apples also do well.

	1	2	3	4
Soil (27)	15	30	38	16
Subsoil (28)	16	28	36	20

	Acres.		Acres.
Columbus, Ohio	26,880	Montgomery County, Ohio	14,000
Fargo, N. Dak	11,968	Pontiac, Mich	1,152
Grand Forks, N. Dak	17,728	Syracuse, N. Y	9,728
Janesville, Wis	51,968	Tazewell County, Ill	34,560
Lyons, N. Y	5,184	Toledo, Ohio	5,504
Marshall, Minn	3,968	Viroqua, Wis	23,552

Miami silt loam.—Light-brown or yellow, sometimes reddish silt loan, from 8 to 12 inches deep, underlain by a plastic silt loam or silt clay of a reddish or yellowish color, grading at 14 to 16 inches into a tenacious silt loam having the proprieties of a clay. Occupies level prairies and slightly rolling areas. Origin is due to the deposition of loess over glacial till. The soil is very fertile, producing good yields of wheat, corn, clover, and timothy hay. The average yield of wheat is 20 to 30 bushels, and of corn from 25 to 50 bushels per acre.

	1	2	3	4
Soil (41)	2	12	70	16
Subsoil (41)	2	11	67	20

	Acres.		Acres.
Bigflats, N. Y	[a] 1,920	Posey County, Ind	149,376
Clinton County, Ill	[b] 9,920	Sangamon County, Ill	92,416
Dubuque, Iowa	[c] 176,896	Syracuse, N. Y	41,536
Janesville, Wis	[b] 81,216	Tazewell County, Ill	[d] 224,960
Knox County, Ill	135,552	Union County, Ky	154,176
Lyons, N. Y	[a] 28,096	Viroqua, Wis	201,408
McLean County, Ill	58,368	Winnebago County, Ill	62,464

[a] Mapped as Elmira silt loam, which name will not hereafter be used.

[b] Mapped as Edgerton silt loam, which name will not be used hereafter.

[c] It is probable that this should have been mapped in part as Marshall silt loam. At the time the differences between the soils locally known as the "clay land" and the "dark loam" did not appear sufficient to justify a separation into two types, but with wider experience in soils of this class, it appears that the latter soil should have been mapped as Marshall silt loam.

[d] Mapped as Tazewell silt loam. It is probable that this soil should have been mapped in part as Miami silt loam and in part as Marshall silt loam.

Miami clay loam.—Light-colored loam, 12 inches deep, underlain by a clay loam, which in turn is underlain by bowlder clay at a depth of 5 feet. Level plains, except adjacent to the streams. Glacial origin. The surface of the country was formerly covered by bowlders, which have largely been removed. One of the best of soils for general agricultural purposes, especially wheat.

	1	2	3	4
Soil (24)	8	20	52	21
Subsoil (24)	6	19	45	29

	Acres.		Acres.
Allegan County, Mich	[a]107,580	Pontiac, Mich	56,384
Columbus, Ohio	222,336	Story County, Iowa	3,072
Madison County, Ind	232,640	Stuttgart, Ark	[b]69,096
Montgomery County, Ohio	240,000	Toledo, Ohio	20,352

Miami black clay loam.—(*For description see under Marshall series, page* 113.)

MARSHALL SERIES.

The Marshall series includes the dark-colored upland soils of the glaciated and loessial region, characterized and distinguished from the Miami series by a large amount of organic matter.

Marshall stony loam.—A dark-brown to black loam or sandy loam 8 inches deep, containing considerable gravel and small stones, underlain by a yellow clay loam mixed with gravel and sand. Very little under cultivation. Used mainly for grazing, to which it is well adapted.

	1	2	3	4
Soil (7)	16	36	34	14
Subsoil (5)	18	29	31	22

	Acres.
Brookings, S. Dak	8,256
Jamestown, N. Dak	30,208

Marshall gravel.—Dark-brown to black sandy loam, containing a high percentage of fine gravel. At 15 to 24 inches it grades into a bed of gravel and coarse sand. With the exception of some pasturage afforded early in the season it has little agriculture value, the crops being small and easily affected by drought.

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[a] Mapped as Allegan clay, which name will not be used hereafter.

[b] While having the same characteristics, the origin is different, and possibly this soil should have been put into some other series.

	1	2	3	4
Soil (6)	50	27	15	7
Subsoil (6)	55	27	11	7

	Acres.
Allegan County, Mich	[a] 14,166
Marshall, Minn	1,216
Pontiac, Mich	6,912

Marshall gravelly loam.—The soil consists of about 12 inches of heavy black sandy loam underlain by 2 feet of coarse gravel usually resting on a coarse sand extending to a depth of 6 feet or more. The gravel is limestone, crystalline rock fragments, or shale. Glacial soil, usually representing beaches along old glacial lakes. This type usually occurs in narrow bands. Except in very wet seasons, the crop yields on this soil are very light.

	1	2	3	4
Soil (7)	23	28	32	17
Subsoil (8)	32	26	23	16

	Acres.
Fargo, N. Dak	2,688
Grand Forks, N. Dak	[b] 51,136
Marshall, Minn	960

Marshall sand.—Dark-brown to black sand, coarse to medium in texture, with an average depth of 10 to 12 inches, with a coarse to medium sandy subsoil, lighter colored than the soil. The soil possesses quite a marked loamy texture, particularly in depressions, owing in part to the admixture of fine silt and clay particles, but chiefly because of the presence of a considerable proportion of organic matter. Occupies narrow ridges, and is characterized by a somewhat hummocky topography. Glacial origin, although exact manner of depostion is not clear. Crop yields are uncertain, but are larger in wet seasons than in dry. Well adapted to vegetables and melons where moisture conditions are favorable or can be controlled.

	1	2	3	4
Soil (1)	38	41	11	10
Subsoil (1)	36	42	13	9

	Acres.
Cerro Gordo, Iowa	1,024

[a] Mapped as Kalamazoo gravelly loam, which name will not be used hereafter.

[b] Mapped as Fargo gravelly loam, which name will not hereafter be used.

Marshall fine sand.—Dark brown to black, rather incoherent sand of fine texture, 10 or 12 inches deep, resting on a lighter-colored sand of about the same texture. Occupies low bluffs bordering river flood plains. Surface is broken and rolling, and the drainage is apt to be excessive, especially where the sandy subsoil is deep. Origin primarily glacial. Crop value varies greatly, depending mainly upon the condition as regards moisture. Is best adapted to early truck crops and melons. It also produces, with the aid of liberal manuring, very good yields of Irish potatoes. It has been used successfully in the production of clover seed, although the yield of hay is very light.

	1	2	3	4
Soil (2)	13	76	5	6
Subsoil (2)	14	77	5	5

	Acres.
Story County, Iowa	13,376

Marshall sandy loam.—A dark-brown to black compact sandy loam about 10 inches in depth, resting on 6 inches of yellowish loam, only less sandy than the surface soil, which is in turn underlain at from 16 to 36 inches below the surface by yellowish clay containing a high percentage of coarse sand and gravel. Rounded pebbles and bowlders occur on the surface, while in the subsoil partly decomposed calcareous nodules are found. Soil occupies gently rolling prairie ridges—thought to be old shore lines—and intervening depressions. The type is mainly of glacial origin. A good general farming type, although in some local areas inclined to be droughty. Average yields: Wheat, 12 to 20 bushels; oats, 20 to 35 bushels; flax, 12 to 15 bushels; potatoes, 100 to 125 bushels per acre.

	1	2	3	4
Soil (7)	27	38	26	9
Subsoil (7)	26	33	24	14

	Acres.
Brookings, S. Dak	93,376
Marshall, Minn	[a]4,480

Marshall loam.—Dark-brown to black loam 10 or 12 inches deep, resting on a lighter colored loam or heavy loam. The deep subsoil consists of clay, sand, gravel, and bowlders mingled together

[a] Mapped in part as Fairview sandy loam, which name will not be used hereafter.

in a disorderly mass. Derived from unstratified glacial drift. Glacial bowlders are found here and there on the surface, in some areas so plentiful as to interfere with cultivation. These are frequently removed from the fields. Occupies gently undulating to rolling country and covers wide areas in the prairies of the Northwest. While extensive areas are well drained and well suited to farming, there are areas of obstructed drainage, resulting in bogs, ponds, and swampy depressions, which are unfit for cultivation without artificial drainage—often a difficult problem. The soil is above the average for general farming purposes. Wheat, oats, corn, barley, and flax are the principal crops. Wheat yields from 10 to 30 bushels; oats from 20 to 80, with an average of 40 bushels; corn from 25 to 45 bushels; barley about 30 bushels; and flax from 9 to 12 bushels per acre. Millet is grown to some extent for hay, yielding from 3 to 4 tons per acre.

	1	2	3	4
Soil (22)	11	30	41	17
Subsoil (23)	11	28	36	24

	Acres.		Acres.
Brookings, S. Dak	135,808	Jamestown, N. Dak	206,976
Cerro Gordo County, Iowa	242,112	Marshall, Minn	108,352
Grand Forks, N. Dak	[a]12,352	Story County, Iowa	303,808

Marshall silt loam.—Dark-brown to black silt loam 10 or 12 inches deep, resting usually on a light-colored, sometimes mottled, silty loam or silty clay. Lime concretions frequently occur. Varies in topography from level to rolling and hilly. Derived from glacial drift or loessial deposits. Drainage generally good but not excessive, the subsoil retaining moisture well and crops resisting drought to a marked degree. Fine soil for the production of wheat, corn, oats, alfalfa, tobacco, and sugar beets, where climatic conditions are favorable.

	1	2	3	4
Soil (32)	3	12	69	16
Subsoil (31)	2	11	70	16

	Acres.		Acres.
Clinton County, Ill	[b]57,472	McLean County, Ill	574,720
Grand Island, Nebr	137,984	Sangamon County, Ill	332,224
Jamestown, N. Dak	41,280	Stanton, Nebr	102,720
Janesville, Wis	[c]81,344	St. Clair County, Ill	[b]106,432
Knox County, Ill	289,088	Winnebago County, Ill	90,624

[a] Mapped as Fargo loam, which name will not be used hereafter.

[b] Mapped as Miami silt loam.

[c] Mapped as Janesville silt loam, which name will not be used hereafter.

Marshall clay loam.—Dark-brown to black clay loam, underlain by a dark-brown clay loam, which becomes a very stiff, yellow clay at about 24 inches below the surface. When moist, the soil is plastic, and feels smooth when rubbed between the fingers; when dry it becomes mellow and friable. This type occupies level or gently rolling prairie uplands. The drainage is generally good. In adaptation this soil is a general farming type, corn, oats, and grass being the leading products. It is, in fact, an ideal corn and hay soil, the yields per acre varying from 25 to 60 bushels of the former and from 1 to 4 tons of the latter. Blue grass makes a luxuriant pasture, the sod being very permanent. Fruit and vegetables also produce well.

	1	2	3	4
Soil (5)	9	19	41	30
Subsoil (5)	11	21	39	30

	Acres.
Cerro Gordo County, Iowa	67,456
Story County, Iowa	8,384

Miami black clay loam.[a]—Black clay loam, 10 to 12 inches deep, underlain by a tenacious drab clay. Of Glacial origin. Generally level, naturally poorly drained. When thoroughly drained this soil is very productive, particularly for corn. It is also well adapted to grass and wheat.

	1	2	3	4
Soil (39)	7	20	53	20
Subsoil (42)	3	13	58	24

	Acres.		Acres.
Allegan County, Mich.	[b]12,460	McLean County, Ill	70,144
Brookings, S. Dak	43,456	Madison County, Ind	31,360
Cerro Gordo County, Iowa	4,032	Marshall, Minn	29,760
Columbus, Ohio	33,792	Montgomery County, Ohio	18,000
Fargo, N. Dak	74,880	Pontiac, Mich	11,840
Grank Forks, N. Dak	44,352	Sangamon County, Ill	88,128
Jamestown, N. Dak	5,120	Story County, Iowa	21,952
Janesville, Wis	1,856	Tazewell County, Ill	61,184
Knox County, Ill	4,928	Toledo, Ohio	165,056

[a] This soil belongs to the Marshall series and should have been called the Marshall black clay loam, but owing to the extensive use of the name the term Miami black clay loam will still be used in all areas.

[b] Mapped as Allegan black clay, which name will not hereafter be used.

Marshall clay.—A heavy black clay loam or clay, 18 to 24 inches deep, resting on a grayish-brown clay extending to a depth of more than 3 feet. The subsoil when exposed to the air breaks up into thin flakes resembling shale or slate. Occupies large areas in the valley of the Red River. Soil is a lacustrine deposit, modified by the addition of river sediments. The drainage is not naturally very good, but has been assisted by the construction of road ditches. A very strong soil, well adapted to wheat, oats, barley, flax, and corn.

	1	2	3	4
Soil (3)	9	20	41	30
Subsoil (3)	0	5	44	51

	Acres.
Fargo, N. Dak	76,800

SIOUX SERIES.

The Sioux series comprises certain dark-colored, low-lying alluvial soils along the rivers and streams in the glaciated area, characterized by a large amount of organic matter and generally underlain by gravel within 3 feet of the surface.

Sioux sand.—Soil consists of from 5 to 20 inches of loose, medium to coarse textured, dark-colored sand. The subsoil, which extends to great depths, has about the same texture as the soil, but is of a light-yellowish color. Forms flat valley lands lying only 5 or 10 feet above mean water level. Naturally well drained and seldom subject to overflow. In narrow valleys where moisture conditions are favorable the type is cleared and cultivated. Broad areas often suffer from drought, and such are left to the native growth of scrubby pine and oak. Soil is sedimentary, but the material is derived more or less locally from underlying sandstone. Used for corn, of which 40 to 80 bushels per acre are obtained under good moisture conditions and heavy fertilization. Vegetables, strawberries, and cranberries also do well on limited areas, but the greater part of the type can only be safely used for agriculture with some system of irrigation.

	1	2	3	4
Soil (2)	38	53	5	4
Subsoil (2)	42	53	3	3

	Acres.
Viroqua, Wis	19,520

Sioux sandy loam.—A coarse to medium brown sandy loam or heavy sandy loam from 10 to 24 inches deep and containing considerable organic matter. The color becomes lighter with depth. The subsoil over wide areas consists of almost pure waterworn gravel, which is found at an average of 22 inches below the surface and which extends to great depths. The subsoil, however, varies considerably, and the gravel is frequently bedded in a matrix of sandy loam, silty sand, or sand. Alluvial soil occupying river terraces or bottoms, with level to gently rolling topography. Drainage is too thorough where the pure gravel subsoil predominates for good crop yields, although the soil is early and might be profitably utilized in the production of early, short-season crops. Hay, corn, oats, and alfalfa are important crops, but the yields are very irregular. In a wet season, or on areas of better moisture conditions, 40 to 60 bushels of corn are obtained per acre, but a dry spell at the critical period of growth often results in total failure. Some truck is grown. Clover and timothy have been produced with fair success.

	1	2	3	4
Soil (10)	30	27	26	16
Subsoil (10)	43	32	14	12

	Acres.		Acres.
Brookings, S. Dak	28,864	Viroqua, Wis	5,568
Cerro Gordo County, Iowa	32,768	Winnebago County, Ill	38,528
Grand Island, Nebr	29,184		

Sioux fine sandy loam.—A dark-gray or black fine sandy loam from 10 to 15 inches deep, containing a relatively high percentage of organic matter, resting on a subsoil of fine to medium sandy loam of a light-brown color. At from 3 to 8 feet below the surface the material changes to sand and gravel. The surface is generally level. The soil is alluvial and occupies both river bottoms and terraces. It generally maintains a good supply of moisture, although in areas of light rainfall irrigation is desirable. The drainage is, on the whole, satisfactory, artificial drains being necessary only in depressed areas. A desirable soil, yielding 15 to 35 bushels of wheat, 25 to 50 bushels of corn, 15 to 60 bushels of oats, about 40 bushels of barley, and 20 bushels of flax per acre. Alfalfa produces well and sugar beets give yields ranging from 8 to 18 tons

per acre. On low-lying areas considerable hay is made from wild grasses.

	1	2	3	4
Soil (5)	12	43	32	11
Subsoil (5)	17	44	28	12

	Acres.
Grand Island, Nebr	60,352
Jamestown, N. Dak	5,632

Sioux clay.—A black, dark-brown, or sometimes yellowish-brown clay loam or clay about 18 inches deep, underlain by a grayish-brown or grayish-yellow clay of stiff, tenacious, waxy texture. Occupies river bottoms, and is partly alluvial and partly a wash from the uplands, the latter areas having the characteristics of the gumbo found in the Red River Valley. An excellent soil for small grain, wheat sometimes yielding as much as 40 bushels per acre. Oats and flax also do remarkably well. The lighter areas are suitable for certain of the truck crops. About half the area of this soil now under cultivation. Native vegetation oak, elm, ash, and other forest trees.

	1	2	3	4
Soil (2)	1	12	46	42
Subsoil (1)	3	14	31	52

	Acres.
Jamestown, N. Dak	2,432

DUNKIRK SERIES.

An important group of soils recognized as the Dunkirk series has been found in well-defined terraces along some of the Great Lakes. These soils are composed of glacial material, reworked and redeposited when the lake waters reached a higher level than at present.

Dunkirk gravel.—Very gravelly soil of old lake beaches, occurring in narrow bands between the lake and uplands. Waterworn fragments of shale, 6 feet or more deep. At present used extensively for grape culture, but grapes do not keep so well or bear shipment so well as those grown on Dunkirk clay. Soil is quite droughty and not well suited to other crops.

	1	2	3	4
Soil (4)	54	11	20	13
Subsoil (2)	77	13	6	5

	Acres.
Ashtabula, Ohio	2,880
Westfield, N. Y.	4,840

Dunkirk gravelly loam.—A sandy loam containing from 40 to 60 per cent of very fine gravel, which consists of waterworn fragments of shale. The soil is underlain at about 3 feet by shale fragments or sand. Occurs in bands along foot of low ridges on lake forelands and also upon uplands. Has the characteristics of an ancient beach or bar, and was probably derived from deposition by water. Sometimes has larger gravel scattered over the surface. It is a well-drained, early soil, adapted to market-garden and truck crops. It is not well suited for most general farming crops, but is a typical corn soil. Grapes are successfully grown.

	1	2	3	4
Soil (4)	45	19	21	11
Subsoil (4)	52	22	16	8

	Acres.
Ashtabula, Ohio	6,528
Westfield, N. Y	7,260

Dunkirk sandy loam.—Sandy loam, 6 to 10 inches deep, underlain by medium or fine sand. Occurs in lake forelands, and is usually marked by hummocky or undulating topography. In part æolian in origin. Adapted to grapes; is also fair grass land.

	1	2	3	4
Soil (4)	8	59	21	11
Subsoil (4)	7	63	19	10

	Acres.
Ashtabula, Ohio	14,720
Westfield, N. Y	22,090

Dunkirk shale loam.—Brown or gray loam, about 7 inches deep, underlain by mottled clay to a depth of 1 to 3 feet. Surface in most places covered with shale fragments from 1 to 4 inches in diameter. Located on escarpment and the steeper slopes. Residual soil derived from shale. Generally covered with timber and underbrush. Less steep positions under vineyards.

	1	2	3	4
Soil (1)	4	19	41	32
Subsoil (1)	6	7	30	50

	Acres.
Westfield, N. Y	21,860

Dunkirk clay.—Soil is a dark to black clay, 6 to 12 inches in depth, underlain by a tenacious, mottled clay, beneath which, at a depth of 4 to 10 feet, occurs the typical bowlder clay. Near ancient beach lines the soil is sometimes underlain by gravel. Found upon lake foreland and in upland valleys. Derived from deposition in quiet water. Some areas badly drained. Adapted to grapes, grain, and grass.

	1	2	3	4
Soil (5)	5	11	32	49
Subsoil (5)	3	17	32	46

	Acres.
Ashtabula, Ohio	8,192
Westfield, N. Y	23,490

MISCELLANEOUS SOILS OF THE GLACIAL AND LOESSIAL REGION.

Holyoke stony loam.—This soil is of glacial origin, and consists of about 3 feet of loam, containing 10 to 50 per cent of diabase and other bowlders. The areas occupied are rough and mountainous, occurring along the base of diabase ranges. The soil is chiefly devoted to pasture, though it is used also to some extent for fruit.

	1	2	3	4
Soil (3)	16	35	38	6
Subsoil (3)	18	43	29	8

	Acres.
Connecticut Valley, Connecticut and Massachusetts	177,088

Alton stony loam.—A grayish or brown silty or sandy loam, 6 to 10 inches deep, containing 25 to 70 per cent of stones and gravel. The subsoil is either a sandy loam of brown color, or a clayey, sandy loam of reddish color, containing 20 to 70 per cent of granite, sandstone, and limestone fragments. Occupies the rolling and level uplands; fairly well drained. Derived through weathering of glacial material. A poor soil. Beans, corn, wheat, oats, and grasses are the main products. Truck and fruit do fairly well.

	1	2	3	4
Soil (7)	21	39	25	14
Subsoil (7)	19	38	26	16

	Acres.
Long Island, N. Y	100,608
Lyons, N. Y	38,208
Syracuse, N. Y	3,712

Plainwell stony loam.—Loose yellow sandy loam, 8 inches deep, underlain by loose yellow medium and fine sand to a depth of 3 feet or more. From 20 to 70 per cent of stones and large bowlders scattered on the surface and mixed with the soil and subsoil. Large rounded hills and ridges. Derived from morainic material. Corn, rye, and buckwheat are grown to some extent, but the yields of these crops are low.

	1	2	3	4
Soil (3)	47	35	12	6
Subsoil (2)	30	43	18	8

	Acres.
Long Island, N. Y	5,376
Pontiac, Mich	1,472

Saugatuck sand.—Soil to a depth of 9 inches consists of reddish-brown, black, and gray sands. Subsoil to a depth of 3 feet or more consists of medium fine sand, containing bands of sand cemented by ferruginous material. These bands of iron crusts vary from a fraction of an inch to 1 or more feet in thickness. Occupies slightly depressed areas. The accumulation of iron is probably due to deficient drainage now or at some former period. Truck, peaches, and small fruits do best, and grain fairly well.

	1	2	3	4
Soil (2)	41	48	7	3
Subsoil (3)	48	44	3	3

	Acres.
Allegan County, Mich	24,120

Clyde sand.—The soil consists of 12 inches of black medium and fine sandy loam, underlain by sand to a depth of 30 inches, in turn generally underlain by clay. Occupies low, flat lands, generally swampy, and borders stream courses. When well drained, produces good crops of corn, wheat, grass, oats, rye, and all kinds of truck crops. Excellent soil for sugar beets.

	1	2	3	4
Soil (3)	21	60	13	4
Subsoil (4)	38	54	5	3

	Acres.
Allegan County, Mich	38,600
Pontiac, Mich	2,880

Shelby sand.—A brown or yellow loamy sand, 10 inches deep, grading into reddish-yellow sand of medium texture, underlain at from 24 to 36 inches by sandstone in place. The subsoil is derived from underlying rock, the soil being a covering of wash material. Occurs as gently rolling upland, just above the second bottoms. Adapted to truck, small fruit, and peaches. Also adapted to wrapper leaf tobacco.

	1	2	3	4
Soil (1)	18	45	28	9
Subsoil (1)	26	52	11	10

	Acres.
Shelby County, Mo	448

Cassadaga sand.—Coarse orange or gray sand, 1 to 3 feet or more deep. Occurs usually in upland valleys. Inclined to be wet or marshy, and needs drainage because of a hardpan subsoil. Very little under cultivation, is usually wooded, and generally has a thick growth of underbrush. Has at present little agricultural value. If it were cleared and drained, it would probably be suited to grass.

	1	2	3	4
Soil (1)	23	44	22	10

	Acres.
Westfield, N. Y.	1,660

Wheatland sand.—Dark-brown sand, 12 to 18 inches deep, underlain by grayish-yellow sand of the same texture. An upland soil of glacial origin. Little agricultural value. Adapted to pasture and grazing.

	1	2	3	4
Soil (3)	12	43	31	13
Subsoil (3)	11	40	34	14

	Acres.
Fargo, N. Dak	29,504

Volusia sandy loam.—The soil is brown or yellow sandy loam, 6 to 10 inches deep, resting upon a fine orange sand 3 feet or more in depth; sometimes contains fragments of shale. Glacial origin from underlying shale material. It is a very productive soil for corn, oats, and potatoes—particularly for the latter, of which large yields are reported. Wheat, however does not do well and

seldom yields even a fair crop. Used for dairying. Small apple orchards numerous.

	1	2	3	4
Soil (2)	12	18	47	16
Subsoil (2)	15	23	38	20

	Acres.
Westfield, N. Y	69,940

Oakland sandy loam.—Loose, loamy brown sand or sandy loam from 10 to 30 inches deep. Sand is from medium to fine in texture. The subsoil is a clay loam or sticky sandy loam. This type differs from the Marshall sandy loam in having this clay subsoil within 3 feet of the surface. It occupies rolling country and often occurs as rounded hills and ridges. Soil is of glacial origin. Drainage is good. Is a good corn soil. This yield could be increased by better methods. Wheat yields from 15 to 30 bushels, oats 35 to 75 bushels, rye from 15 to 30 bushels, and hay 1½ to 2 tons per acre. The soil is used for general agriculture, but it is especially adapted to medium and late truck crops and fruit.

	1	2	3	4
Soil (3)	16	40	31	13
Subsoil (3)	12	31	31	25

	Acres.
Pontiac, Mich	25,984

Manchester sandy loam.—A reddish or dark-yellow sandy or gravelly loam, of the medium grade of sand, from 8 to 18 inches in depth, underlain by loamy sand and gravel, containing frequent large bowlders. The surface is generally rolling, in the form of ridges and knolls, though the type occasionally occurs as low, flat terraces. A combination of glacial lake and stream deposits, and the material is exceedingly irregular in thickness. It is formed in part of the red Triassic rocks. The soil is naturally fertile, but the porous subsoil renders it readily subject to drought. Well adapted to peaches and fairly well adapted to corn.

	1	2	3	4
Soil (2)	33	50	11	6
Subsoil (2)	41	46	10	4

	Acres.
Connecticut Valley, Connecticut and Massachusetts	44,160

Winnebago sandy loam.—A brown to slightly reddish sandy to heavy sandy loam, often containing considerable silt. The sand is coarse to medium. Varies considerably in character and depth, but averages about 10 inches. The subsoil is about the same in texture, but more often of a reddish-brown color. From 18 to 36 inches it is underlain by a gravelly till. The surface is rolling and uneven. Underdrainage is good. It is a very good corn soil, although the average yield is not over 30 bushels per acre. Oats are extensively grown, giving about the same yield as corn. Clover, timothy, and rye also do well.

	1	2	3	4
Soil (2)	26	36	25	15
Subsoil (4)	25	34	22	19

	Acres.
Winnebago County, Ill	88,160

Wheatland sandy loam.—Dark-brown sandy loam, about 14 inches deep, underlain by loam, which at a depth of 6 feet or more rests upon a grayish-yellow or yellow glacial till. Glacial bowlders and rock fragments occur throughout the soil and subsoil. Upland soil, generally well drained. Fairly well adapted to wheat, oats, barley, flax, and corn.

	1	2	3	4
Soil (6)	9	44	26	22
Subsoil (6)	18	33	23	29

	Acres.
Fargo, N. Dak	16,768

Janesville loam.—A fine brown loam, 12 to 14 inches deep, underlain by a firm massive yellow loam of very uniform texture. Surface almost uniformly level; underdrainage good. Excellent grain and tobacco soil.

	1	2	3	4
Soil (3)	2	7	71	20
Subsoil (3)	3	8	74	16

	Acres.
Janesville, Wis	6,656

Derby loam.—This type is a mellow yellowish-brown to reddish-brown silty loam, 10 inches deep, grading almost imperceptibly into a rather heavy reddish-brown silty loam subsoil. Occupies rolling upland prairie and is well drained. A good soil for general

agriculture. Corn and wheat the chief crops. Yield of corn 25 bushels, and of wheat 18 bushels per acre.

	1	2	3	4
Soil (2)	4	35	42	19
Subsoil (2)	5	30	45	20

	Acres.
Wichita, Kans	20,416

Volusia loam.—A brown or black loam, 6 to 10 inches deep, resting on a yellow silty loam containing shale fragments and having a depth of 3 feet or more, in turn underlain by shale rock. The surface is strewn with shale and slate fragments and occasional erratic glacial bowlders. Occurs typically developed upon heavy rolling uplands, but extends down into the foreland along the lake. Derived from morainic material. Crops: Wheat, corn, and at lower elevations, grapes.

	1	2	3	4
Soil (5)	5	20	46	27
Subsoil (5)	11	22	40	25

	Acres.
Ashtabula, Ohio	173,440
Westfield, N. Y	10,030

Elmwood loam.—(*See description under soils associated with Norfolk series.*)

Warners loam.—The soil consists of 10 inches of mellow brown loam, containing many calcareous nodules and a considerable proportion of marl, resting on a subsoil of white or gray marl. Silty in character and of soft, unctuous feel, containing thin layers of muck at various depths. Fairly good crops of corn and grass.

	Acres.
Syracuse, N. Y	128

Jackson loam.—Light loam with an average depth of 14 inches, grading into a mottled sandy clay or clay subsoil. Occurs as second bottom, with a gently rolling surface. Is an alluvial soil. Produces about 15 bushels of wheat and from 25 to 40 bushels of corn per acre. Onions give large yields. Well adapted to light farm crops and to truck, wrapper tobacco, and peaches.

	1	2	3	4
Soil (2)	1	38	50	12
Subsoil (2)	2	41	44	14

	Acres.
Shelby County, Mo	2,304

Madison loam.—Loose, friable brown or yellow loam or fine sandy loam, from 8 to 14 inches deep, resting upon a heavy loam or clay, usually becoming heavier below 24 inches. Throughout the soil and subsoil there are a few well-rounded gravel. The subsoil is somewhat variable, occasionally consisting of alternating layers of sand and clay, with an occasional layer of cherty gravel. Occurs as second bottoms, generally level. An alluvial soil, derived from wash of valley slopes. Frequently the drainage is poor. Is a good soil for corn and hay and for truck crops, especially for cabbage, tomatoes, and berries.

	1	2	3	4
Soil (2)	8	25	40	27
Subsoil (2)	8	29	40	25

	Acres.
Madison County, Ind	2,240

Bernardston loam.—Light clay or silty loam of dark color, 10 inches in depth, underlain by about 14 inches of a dark to yellowish loam grading into a dark slaty blue clay loam of very compact nature. This soil seems to be derived from the same class of material as the Hobart clay, but it is a soil of very much lighter texture. It occurs in very broken and hilly areas, and outcrops of the underlying argillaceous rocks are very common. Cultivated soils occur very largely in drumlinoid hills. Native vegetation is made up largely of hard woods, particularly sugar maple, but in the most stony areas, where the soil is shallow, chestnut, pine, and hemlock are common. It is a glacial soil, made up of argillaceous rock material. It is very fertile, being particularly fine for grass and grazing land. Also produces excellent crops of corn, oats, and rye.

	1	2	3	4
Soil (2)	18	34	34	14
Subsoil (2)	16	33	36	15

	Acres.
Connecticut Valley, Connecticut and Massachusetts	16,064

Memphis silt loam.—Fine yellow or brown silt loam, 0 to 8 inches, powdery when dry; chocolate-brown loam 8 to 40 inches, underlain at from 2 to 6 feet by yellow silt of loess formation. Occupies uplands. Subject to serious erosion. Only about 20 per cent of total area cultivated. Largely forested to oak, hickory, and beech.

In Mississippi divided topographically into two regions, the Cane Hills, which are steep sided and narrow topped, and the Flat Hills, which are more plateaulike and cultivated to a greater extent than the Cane Hills. Cotton, three-eighths to one-half bale per acre. In northern areas good for fruits and vegetables.

	1	2	3	4
Soil (11)	1	5	81	12
Subsoil (11)	1	6	75	17

	Acres.		Acres.
Johnson County, Ill	167,104	Union County, Ky	17,984
Posey County, Ind	9,408	Yazoo, Miss	140,090
Smedes, Miss	52,288		

Delavan silt loam.—Is a brown, smooth, crumbly, nonplastic silt loam, 12 inches deep, underlain by a reddish-yellow, heavier silt loam, which in turn is underlain by a fine sand at from 65 to 75 inches. Occurs principally in the southwestern part of Tazewell County. Is level and does not require artificial drainage. An exceedingly fertile soil, very highly esteemed for corn and small grain.

	1	2	3	4
Soil (2)	2	8	69	21
Subsoil (2)	1	12	75	13

	Acres.
Tazewell County, Ill	25,600

Elkhorn silt loam.—A black loamy soil, containing a large amount of organic matter, resting on a black loam of the same character, usually grading into a yellowish loam at a depth of 24 inches. Occupies level bottom lands from 6 to 20 feet above mean water level. Subject to inundation during spring freshets. The drainage is poor. Formed from loess, reworked by the river and modified by wind action. Productive soil. Corn yields from 30 to 60 bushels, wheat from 12 to 30 bushels, oats from 30 to 50 bushels, and sugar beets from 8 to 18 tons per acre.

	1	2	3	4
Soil (2)	2	33	57	9
Subsoil (2)	1	26	63	11

	Acres.
Stanton, Nebr	25,152

McLean silt loam.—Dark-brown to black silty loam soil, about 12 inches deep, underlain by a mottled-yellow friable silt of a

hard, compact nature. At about 22 inches this grades into a gravelly till. This soil is very similar to the Marshall silt loam, but differs from it in having the till nearer the surface. The surface is broken and hilly and the drainage is generally good except in the more level areas. Corn averages about 30 to 35 bushels and oats about the same. It is fairly good for hay. This type may be classed as a fair soil for general farming, though less desirable than the Marshall silt loam and requiring more careful treatment.

	1	2	3	4
Soil (1)	6	13	53	28
Subsoil (2)	6	14	48	32

	Acres.
McLean County, Ill	17,984

Shelby silt loam.—A silt or clay loam, from 6 to 10 inches deep, grading into a stiff, dense, impervious clay. Plastic and waxy when wet, friable and loamy when dry. The soil is a dark-gray color; the subsoil is a dark, mottled clay, brown or drab, streaked with blue and red. Known locally as "the prairie," and occupies level to gently rolling uplands. Supposed to be of loessial origin. The greater part is fairly well drained, but the impervious subsoil causes water to collect on very level areas after heavy rains. Fairly easy to cultivate. Principal crops are hay, corn, oats, and wheat, with millet, Kafir corn, and sorghum as secondary crops. Hay yields from 2 to 3 tons, corn 35 to 40 bushels, wheat 15 to 20 bushels, Kafir corn 20 to 40 bushels, and millet 30 to 40 bushels of seed per acre. The type is a typical grass soil, and large quantities of seed are produced. Fruit also does well, and the production of apples is of some importance.

	1	2	3	4
Soil (3)	3	4	74	19
Subsoil (3)	4	4	55	38

	Acres.
Shelby County, Mo	216,896

Marion silt loam.—Consists of silt loam of light-brown to white color, with an average depth of 12 inches. Subsoil consists of a hard, stiff silty clay of mottled appearance, locally known as hardpan, the predominating colors being gray, light yellow, and reddish yellow. Between the soil and subsoil occurs a white layer of compact silt, which crumbles easily between the fingers. Occupies the

level prairie land. Of loessial origin. Wheat, corn, and grass are the principal crops. Yield of grains rather small. Apples do well.

	1	2	3	4
Soil (9)	3	7	76	14
Subsoil (13)	3	7	63	26

	Acres.
Clay County, Ill	260,544
Clinton County, Ill	172,480
St. Clair County, Ill	86,464

Waverly silt loam.—A light-brown to white silty loam about 10 inches in depth, underlain by a grayish or yellowish silty loam of closer texture. Occupies bottom lands and marshy depressions. Owes its origin to sediments washed from adjoining prairies, reworked with organic matter. Corn principal crop.

	1	2	3	4
Soil (14)	2	9	73	16
Subsoil (14)	2	9	72	16

	Acres.		Acres.
Clay County, Ill	30,976	Posey County, Ind	16,384
Clinton County, Ill	40,112	St. Clair County, Ill	25,152
Johnson County, Ill	31,936	Union County, Ky	25,216

Elmira shale loam.—Light-gray loam, 10 or more inches in depth, containing considerable silt and fine sand. The subsoil, from 10 to 24 inches below the surface, is of the same texture as the soil, but lighter in color, and contains large quantities of angular shale fragments or bowlders. All general farm crops are raised, but to obtain the best results a liberal application of manure is required.

	1	2	3	4
Soil (3)	9	24	51	16

	Acres.
Bigflats, N. Y	8,512

Alloway clay.—(*See description under soils associated with Norfolk Series.*)

Griffin clay.—A very compact soil, composed of medium to fine gravel, coarse sand rounded by water action, and clay. The clay is dark brown or mottled in color, very stiff and waxy, and difficult to work. There is an average gravel content of about 10 per cent. Occupies the broad, level floor of Black River Valley. Alluvial in origin, and the presence of so much gravel may be due to the reworking of glacial material. A large proportion of the

type is covered by forest. Corn is the chief product, but considerable areas are devoted to wheat and oats.

	1	2	3	4
Soil (1)	33	17	25	25
Subsoil (1)	37	17	20	26

	Acres.
Posey County, Ind	1,600

Shelby clay.—Fine sandy or silty loam of a gray or brown color, from 3 to 8 inches deep, grading into a reddish-yellow sandy clay which extends to a depth of 3 feet or more. Locally termed "white oak lands." Iron pipes and concretions are usually found. The subsoil is made up mainly of pockets of sand and clay with occasional thin lenses of cherty gravel. Is of glacial origin occurring below the Shelby silt loam, and exposed through stream cutting and erosion of the overlying prairie. Occupies steep slopes adjacent to the water courses. Native growth is white and scrub oak with a scattering of red oak and hickory. Much less productive than the Shelby silt loam. Adapted to pasturage and poorly adapted to wheat and corn. The former yields an average of about 10 bushels and the latter about 25 bushels per acre. Used almost exclusively for pasture.

	1	2	3	4
Soil (3)	14	32	40	13
Subsoil (3)	12	20	25	40

	Acres.
Shelby County, Mo	71,168

Hobart clay.—A shallow covering of from 1 to 4 inches of a gray or dark-brown clay, underlain to a depth of 3 or 4 feet by heavy drab-colored clay. Below this the subsoil is mixed with fragments of the underlying shale, and finally grades into shale rock. The soil as well as the subsoil contains fragments of shale. When the soil is wet, it is very adhesive under foot and has a greasy, oily feel. In dry weather it often bakes to the detriment of growing crops. On account of the impervious clay and shale underlying these soils, there are many fresh-water springs. Owing to the stiff tenacious character of the soil and its location on the steep sides of bluffs it has little value except as a sheep and cattle pasture.

	1	2	3	4
Soil (2)	1	2	14	85

	Acres.
Jamestown, N. Dak	3,712

Fargo clay.—Heavy black clay 6 to 14 inches deep, underlain by gray or blue clay of the same texture. At from 5 to 9 feet occurs a mottled gray, brown, and yellow clay, similar to the subsoil of the Miami black clay loam. When wet this type is very waxy and gummy and has an oily feel. It is exceedingly slippery under foot and often sticks to wagon wheels in great quantities. Very difficult to till. Occurs in depressions in the upland. Drainage poor. Very strong and productive soil when well drained. Adapted to general farm crops.

	1	2	3	4
Soil (2)	3	12	36	50
Subsoil (2)	1	7	26	66

	Acres.
Fargo, N. Dak	40,000

RESIDUAL SOILS OF THE PRAIRIE REGION.

OSWEGO SERIES.

The soils of this series are derived from interbedded sandstone, limestone, and shale.

Oswego fine sandy loam.—A yellowish-brown heavy fine sandy loam with a depth of 12 inches resting on a subsoil of the same material of a lighter yellowish color and somewhat heavier in texture. This is an upland soil occupying low, rounded knobs and ridges, and having a rolling surface. The drainage is excellent. The type is residual, being derived from sandstone and arenaceous shale, which occurs in places a few feet beneath the surface. Corn and oats are the important crops, the former yielding from 20 to 30 bushels, and the latter about 25 bushels per acre. Very little wheat is grown on this soil, as it is likely to winter-kill. Best adapted to fruit and truck.

	1	2	3	4
Soil (2)	2	52	32	14
Subsoil (2)	2	50	32	17

	Acres.
Parsons, Kans	9,728

Oswego loam.—A gray to yellowish silt loam, 0 to 10 inches deep, grading into a stiff clay, becoming stiffer and more impervious as the depth increases. Occupies gently rolling upland prairies. De-

rived from shale, with here and there an interbedded layer of sandstone or limestone, and in places outcrops of bituminous coal. When dry is apt to bake and crack, but breaks up into a mellow loam when plowed. A soil of fair productivity, used for general farm crops. The average yield of wheat is about 18 bushels, of corn 25 bushels, and of potatoes 80 to 100 bushels per acre. Flax and rye are grown to some extent.

	1	2	3	4
Soil (3)	3	22	57	17
Subsoil (3)	3	17	52	28

	Acres.
Parsons, Kans	92,096

Oswego silt loam.—The surface soil is ashy-white, fine, soft, flourlike silt loam, with a depth of 12 inches, changing abruptly at that depth into a stiff, very impervious drab to reddish-colored silty clay, locally know as hardpan. Found in nearly level areas. Origin a matter of conjecture, for while overlying the shale rock and being, it is thought, partly or wholly derived therefrom, the remarkably uniform depth of soil and sharp demarcation between the soil and subsoil, together with the existence of layers of water-worn gravel, sometimes found at 18 or 20 feet below the surface, seem to indicate the agencies of water or wind, or both, in the formation of the type. Soil clods badly if plowed when too moist, but is easily put in good tilth by further cultivation. The type is not a strong soil but could be brought to a much higher state of productiveness by manuring, plowing under green crops, and deeper plowing. Wheat, corn, and hay are the principal crops, yielding, respectively, an average of 15, 25, and 15 bushels per acre. Flax, formerly grown, produced 10 bushels per acre. Wild hay, an important product, yields from 1 to 1½ tons per acre. Sweet and Irish potatoes and melons give fairly good yields. Seems best adapted to grass and wheat.

	1	2	3	4
Soil (3)	1	12	72	14
Subsoil (3)	1	7	65	27

	Acres.
Parsons, Kans	21,568

SEDGWICK SERIES.

Sedgwick sandy loam.—A medium to fine reddish-brown or chocolate-brown sand 10 inches deep, underlain to depth of 20 inches by a reddish-brown sticky sand, resting on a heavy sandy clay. Occupies rolling upland prairie west of Arkansas River. Adapted to corn, wheat, and other grains. Also a good soil for fruit.

	1	2	3	4
Soil (4)	21	45	24	9
Subsoil (4)	21	36	25	18

	Acres.
Russell, Kans	24,064

Sedgwick loam.—Consists of a fine mellow reddish-brown loam, 10 inches deep, underlain by a heavy, somewhat tenacious brown loam, containing considerable fine sand. Occupies rolling upland prairie, is easily cultivated, and usually well drained. Derived from unconsolidated material of Tertiary age. Adapted to ordinary farm crops, such as corn, wheat, oats, and Kafir corn.

	1	2	3	4
Soil (3)	10	21	60	10
Subsoil (3)	10	19	57	11

	Acres.
Wichita, Kans	47,040

Sedgwick clay loam.—A chocolate-brown to dark-brown friable silty loam about 9 inches deep; at from 9 to 20 inches it grades from a heavy brown clay loam to a dark-brown clay; at from 20 to 36 inches it becomes lighter in color and more silty. When wet the soil is very sticky, and in drying forms a thin crust on the surface. Occupies a high rolling prairie and is well drained. Derived from the weathering of Carboniferous limestones and shales. Adapted to the production of corn, wheat, hay, fruit, and vegetables.

	1	2	3	4
Soil (6)	2	13	73	12
Subsoil (6)	2	9	74	15

	Acres.
Russell, Kans	91,648

Sedgwick black clay loam.—A fine-grained black silty loam, 12 inches deep, underlain by a tough heavy bluish-gray to drab clay, extending to a depth of 3 feet or more. Occupies flat or depressed areas on upland prairie, and is poorly drained. Formed from

wash from the surrounding soils. Generally used only for pasture, although thorough drainage converts it into land well adapted to wheat and corn.

	1	2	3	4
Soil (1)	3	39	48	9
Subsoil (1)	1	17	52	31

	Acres.
Wichita, Kans	5,568

MISCELLANEOUS RESIDUAL SOILS OF THE PRAIRIE REGION.

Lincoln sandy loam.—The soil is a light-gray to brown sandy loam from 0 to 15 inches in depth, resting on a lighter colored material slightly more sandy than the soil. Occupies low, flat areas bordering streams, and is a pure alluvial in origin. Not subject to overflow, and in general well drained. Best adapted to corn and alfalfa, which sometimes suffer from drought owing to the loose porous nature.

	1	2	3	4
Soil (3)	5	68	18	9
Subsoil (3)	5	62	22	10

	Acres.
Russell, Kans	8,822

Benton loam.—A light-brown or grayish silty loam from 3 to 12 inches deep, often containing small fragments of shale and limestone, resting on a subsoil of lighter color, almost wholly made up of partially decomposed shale, but carrying a small proportion of limestone, also in various stages of disintegration. At a depth of from 25 to 36 inches the rotten shale and limestone in the subsoil often appear as soft chalky particles. The soil occurs along the banks and ridges bordering streams, and the topography is rough and broken. The drainage is rapid, and if anything too thorough, while the steeper slopes are subject to erosion. The soil is residual, being derived from layers of fossiliferous shale and limestone. Supports a good growth of grasses, and because of its rough, uneven surface it is used mainly for pastures. On the more level slopes Kafir corn and sorghum are grown. Well adapted to stock raising.

	1	2	3	4
Soil (2)	13	25	32	32
Subsoil (2)	13	20	25	42

	Acres.
Russell, Kans	35,456

Waldo loam.—Brown or grayish-brown silty loam, about 12 inches deep, resting on a subsoil of the same character, but of lighter color and becoming heavier with depth. Bottom soil along smaller streams. Derived from the erosion of limestone and shale. It is well drained and not subject to overflow. The average yield of wheat, from 12 to 15 bushels; of corn, 25 to 30 bushels per acre. Alfalfa produces from 4 to 5 tons per acre. In general the soil is well adapted to agricultural purposes.

	1	2	3	4
Soil (3)	3	23	58	15
Subsoil (3)	2	17	62	19

	Acres.
Russell, Kans	12,864

SOILS OF THE FAR WEST.

MARICOPA SERIES.

This series is made up of colluvial soils of granitic origin.

Maricopa stony loam.—Sandy loam 4 to 6 feet deep, containing stones and bowlders, underlain by bed rock and masses of bowlders. These often project above the surface. Lower slopes of the mountains. Has little agricultural value at present, being too stony, and besides usually lying too high for irrigation. But for this disadvantage of position in most areas and the scarcity of water in others, some part of this soil might be used in fruit growing.

	Acres.		Acres.
Provo, Utah	33,728	Sevier Valley, Utah	[a] 4,210
Salt Lake, Utah	[a] 16,600	Weber County, Utah	[a] 5,700

Maricopa gravelly loam.—Sandy loam 6 feet or more in depth, containing gravel within 3 feet or less of the surface; always well drained. Gravel usually from one-half inch to 1½ inches in diameter, generally increasing in amount in lower depths. High bench lands and sloping valley floors in narrow valleys. When too high for irrigation this soil is used to some extent for dry farming to wheat. When irrigated it forms desirable land for

[a] Mapped as Bingham stony loam, which name will not be used hereafter.

alfalfa, grain, and fruit. In California fruit is grown on this soil without irrigation. Considerable seepage from canals.

	1	2	3	4
Soil (22)	16	41	26	13
Subsoil (10)	14	44	26	12

	Acres.		Acres.
Baker City, Oreg	17,216	San Gabriel, Cal	[b]15,360
Los Angeles, Cal	5,952	Sevier Valley, Utah	[a]38,400
Provo, Utah	48,128	Solomonsville, Ariz	12,864
Salt Lake, Utah	[a]35,280	Ventura, Cal	[b]4,310
Salt River Valley, Ariz	51,066		

Maricopa sand.—A coarse, loose, incoherent sand, 3 feet deep, underlain by sandy loam grading to sandy adobe. Occupies higher slopes and levels. Has excellent natural drainage. Owes its origin to deposition by streams.

	1	2	3	4
Soil (2)	20	47	25	9
Subsoil (1)	18	54	21	7

	Acres.
Lower Arkansas Valley, Colo	14,208
Solomonsville, Ariz	17,728

Maricopa sandy loam.—Sandy loam with less than 10 per cent of gravel, 3 feet in depth, underlain by sandy loam containing layers of calcareous hardpan. Composed of colluvial granitic material. Medium elevation in Salt River Valley, Arizona. Adapted to alfalfa, fruit, and grain.

	1	2	3	4
Soil (19)	19	41	24	13
Subsoil (9)	16	34	31	18

	Acres.		Acres.
Baker City, Oreg	30,784	Salt River Valley, Ariz	106,906
Los Angeles, Cal	13,888	Solomonsville, Ariz	10,368
Lower Arkansas Valley, Colo	156,096		

Maricopa loam.—Reddish loam, 3 to 6 feet in depth, underlain by loam containing layers of calcareous hardpan. Lower valley land. Colluvial soil, derived from finer waste of mountain slopes. Adapted to alfalfa and grain.

[a] Mapped as Bingham gravelly loam, which name will not be used hereafter.

[b] Mapped as San Gabriel gravelly loam, which name will not be used hereafter.

	1	2	3	4
Soil (3)	7	33	26	27
Subsoil (3)	9	39	26	22

	Acres.
Salt River Valley, Ariz	20,650

Maricopa silt loam.—A heavy brownish silt loam, with a depth of 6 feet or more. The soil has an exceedingly fine texture, crumbling to an impalpable powder when dry, but becoming very sticky when wet. It is easily puddled, bakes upon exposure to the sun, and somewhat resembles an adobe in physical characteristics. Erodes into vertical walls, washes, and gullies. Except as very small particles, the occurrence of gravel on the surface is rare. Occurs in valleys and along streams. Generally level, except where cut by washes. Native vegetation is sparse and often wanting on wind-swept areas. Both surface and subdrainage is apt to be deficient. Some alkali accumulations where irrigated. Best adapted to alfalfa, wheat, barley, sorghum, Egyptian and Indian corn, and sugar beets.

	1	2	3	4
Soil (2)	1	7	68	25
Subsoil (3)	0	19	56	25

	Acres.
Solomonsville, Ariz	11,648

Maricopa clay loam.—Stiff reddish clay loam, 6 feet or more in depth. Low valley land. Colluvial soil, heaviest product of the wash from the mountain slopes. Adapted to grain crops, but rather heavy and compact for alfalfa.

	1	2	3	4
Soil (1)	10	21	38	31
Subsoil (1)	2	15	53	29

	Acres.
Lower Arkansas Valley, Colo	832
Salt River Valley, Ariz	8,713

Maricopa sandy adobe.—A yellowish-brown or reddish sandy adobe 6 feet or more in depth. Occupies lower levels. Drainage good. Owes its origin to stream wash and disintegration of rocks in place. Contains some alkali. Alfalfa principal crop, but good yields of sorghum, corn, wheat, and oats are produced.

	1	2	3	4
Soil (2)	7	50	28	16
Subsoil (2)	6	45	24	26

	Acres.
Lower Arkansas Valley, Colo	37,284

FRESNO SERIES.

The Fresno series and associated soils are of granitic origin, and occupy valleys and Pacific Coastal plain.

Fresno sand.—Coarse, loose, incoherent sand, 6 feet or more in depth, naturally free from alkali. Level plains, deltas; of sedimentary origin. Adapted to stone fruits and truck when irrigated; occasionally dry-farmed to wheat. Is used for English walnuts. Similar to Norfolk sand truck soils of the Eastern States.

	1	2	3	4
Soil (31)	30	54	10	4
Subsoil (9)	27	47	16	6

	Acres.		Acres.
Fresno, Cal	163,200	Provo, Utah	10,368
Hanford, Cal	20,790	Salt Lake, Utal	[a]3,020
Indio, Cal	50,112	San Gabriel, Cal	[b]45,420
Los Angeles, Cal	58,112	Santa Ana, Cal	66,380
Lower Arkansas Valley, Colo	95,680	Ventura, Cal	6,430
Lower Salinas Valley, Cal	25,030	Weber County, Utah	[c]23,700

Fresno red sand.—This soil consists of compact red sand of medium texture to a depth of 6 feet or more. It is derived from disintegration of crystalline rocks. This material has been carried down from the mountains and distributed usually in gentle slopes by foothill streams. The surface is also somewhat modified by wind action. It is well drained, free from alkali, and adapted to vines, stone fruits, and truck crops.

	1	2	3	4
Soil (5)	42	48	7	5

	Acres.
Fresno, Cal	43,776

Fresno fine sand.—Dark-reddish fine sand, micaceous, usually 6 feet or more in depth, but often streaked with coarse sedimentary deposits. Sometimes underlain by sand or fine sandy loam. Occurs in level delta plains and low river terraces. Derived largely from disintegration of granitic rocks. Generally well

[a] Mapped as Jordan sand, which name will not be used hereafter.

[b] Mapped in part as San Gabriel gravelly sand, but now included as a gravelly phase of Fresno sand.

[c] Mapped in part as Jordan sand, which name will not be used hereafter.

drained, but at times (in the Hanford area) alkaline. Excellent fruit soil. Used for alfalfa, beets, potatoes, and truck crops.

	1	2	3	4
Soil (7)	12	58	24	6
Subsoil (6)	13	46	29	8

	Acres.		Acres
Hanford, Cal	[a]51,250	Los Angeles, Cal	16,128
Lower Arkansas Valley, Colo.	5,952	Lower Salinas Valley, Cal	17,040

Fresno sandy loam.—Sandy loam or very fine sand with properties of sandy loam, 3 feet in depth, white in color, ashy texture, and locally known as "white-ash land," underlain by bluish calcareous alkali hardpan, which softens upon application of water. Lower, level plains of Fresno County, Cal., derived from degradation of beds of sand, clay, and volcanic ash. Generally contains alkali; when free from such it is an excellent grape and fruit soil.

	1	2	3	4
Soil (12)	6	53	26	12
Subsoil (10)	8	54	29	9

	Acres.
Fresno, Cal	69,811
Hanford, Cal	10,860
Indio, Cal	36,032

Fresno fine sandy loam.—Fine sand having the properties of a sandy loam to a depth of from 3 to 6 feet, grading into a coarse sand. Coastal and delta plains of rivers. Well adapted to such crops as alfalfa, Lima beans, and grain, and truck crops, but not so well adapted to fruit, except when well drained. A fine English walnut soil in Southern California.

	1	2	3	4
Soil (24)	5	48	34	9
Subsoil (18)	7	53	28	11

	Acres.		Acres.
Indio, Cal	36,032	Santa Ana, Cal	11,552
Lower Arkansas Valley, Colo.	236,288	Ventura, Cal	12,900
Lower Salinas Valley, Cal	18,130	Weber County, Utah	86,400
San Gabriel, Cal	10,790		

[a] Mapped as Hanford fine sand, which name will not be used hereafter.

SOILS ASSOCIATED WITH THE FRESNO SERIES.

Soledad gravelly sand.—Very coarse brown sand and fine gravel, composed of sharp fragments of granitic rocks and 6 feet or more in depth. Occurs upon large fans of from 3° to 5° slope, extending from granitic foothill formation. Surface sometimes becomes compact and very hard, especially when packed in roads. Rather deficient in plant food and not retentive of moisture. Adapted to grain, with fair yields in favorable seasons. Free from alkali.

	1	2	3	4
Soil (1)	51	23	13	9

	Acres.
Lower Salinas Valley, Cal	7,600

Hanford fine sandy loam.—Dark-colored fine sandy loam, micaceous, 4 feet in depth, underlain usually by 2 feet or more of loam or sandy clay. Occurs in level delta plains, and is derived largely from the disintegration of granitic rocks. Good corn and grain land; also valued for vineyards. Generally free from alkali. Probably should have been correlated with Fresno fine sandy loam.

	1	2	3	4
Soil (2)	9	37	34	15
Subsoil (2)	7	37	42	12

	Acres.
Hanford, Cal	30,010

Salinas gray adobe.—Dark-gray adobe, grading in texture from sandy loam containing considerable fine gravel to silt loam. Occurs about edge of foothills and extends into the bottom lands. Thirty inches or more in depth, usually underlain by a fine sandy loam and fine sand, occasionally by coarse sand and gravel. Seems to be derived largely from granitic material. Adapted to barley and other grains and sugar beets. A loose, friable, and excellent soil if irrigated and properly cultivated, but refractory if allowed to bake. Generally free from alkali.

	1	2	3	4
Soil (5)	9	21	38	31
Subsoil (5)	13	27	30	27

	Acres.
Lower Salinas Valley, Cal	18,400

San Joaquin red adobe.—Sticky red adobe, with texture of loam, 6 feet in depth; usually a layer of red sandstone hardpan in lower 3 feet. Margins of plains adjacent to foothill streams; derived from foothill stream wash. Adapted to grain crops.

	1	2	3	4
Soil (3)	18	45	24	10
Subsoil (1)	15	36	26	19

	Acres.
Fresno, Cal	12,691

San Joaquin black adobe.—Heavy black or brown adobe soil, 4 to 6 feet deep. Subsoil varies from sandy adobe to heavy clay adobe, or it may be decomposing shale. Margins of valleys along foothill streams in California, often extending out into the valleys. Derived from crystalline rocks or shale. Soil is difficult to till, but very productive. Adapted to grain crops and used at present for citrus fruits where water supply is adequate.

	1	2	3	4
Soil (18)	5	18	39	34
Subsoil (17)	2	15	43	36

	Acres.		Acres.
Fresno, Cal	5,664	San Gabriel, Cal	23,650
Hanford, Cal	5,470	San Jose, Cal	30,400
Los Angeles, Cal	37,440	Santa Ana, Cal	16,038
Lower Arkansas Valley, Colo	4,096	Ventura, Cal	4,290
Lower Salinas Valley, Cal	11,580		

YAKIMA SERIES.

This series is derived mainly from the disintegration of basaltic rocks and volcanic ash material.

Yakima stony loam.—Basaltic bowlders and outcroppings in too great quantity to permit of cultivation. Space between bowlders occupied by small patches of Yakima sandy loam. Occurs on hillsides and plateaus in valleys. Well drained and free from alkali.

	Acres.
Yakima, Wash	8,960

Yakima gravelly loam.—A loam soil containing from 25 to 80 per cent of rounded, waterworn basaltic gravel, usually from one-half inch to 3 inches in diameter. Occupies valleys along small

streams, and has been formed by material brought down from higher levels by these streams. Greater part used for pasture, although when cleared and cultivated, well adapted to the growth of fruits, vegetables, and small berries.

	1	2	3	4
Soil (1)	13	33	44	8

	Acres.
Walla Walla, Wash	10,048

Yakima sand.—Medium and fine sand, a few inches to 6 feet in depth. Underlain by sandy loam of same composition as Yakima sandy loam. Of æolian origin, occurring in dunes and drifted areas. Adapted to hops, fruit, berries, alfalfa, grass, and truck, but difficult to cultivate on account of drifting. Generally well drained and free from alkali in its uncultivated condition.

	1	2	3	4
Soil (4)	16	67	12	4
Subsoil (3)	2	56	35	4

	Acres.
Blackfoot, Idaho	31,104
Boise, Idaho	[a] 17,430
Yakima, Wash	[b] 20,660

Yakima fine sand.—A light brown, gray, or ash-colored sand 3 feet deep, underlain by sand or gravel. Occupies low, level terraces or benches along Clearwater River. Easy to cultivate, and owes its origin to weathering of blended alluvial deposits. Fruit the principal product.

	1	2	3	4
Soil (3)	5	54	32	5
Subsoil (1)	8	51	33	7

	Acres.
Lewiston, Idaho	2,112

Yakima sandy loam.—Grayish, fine sandy loam, 6 feet or more in depth, with occasional strata of fine sand and bands of volcanic ash in surface 6 feet. Occupies hills, slopes, and level valley floors. Adapted to hops, fruits, and hay crops.

	1	2	3	4
Soil (17)	7	30	52	9
Subsoil (16)	5	24	58	11

[a] Mapped as Snake River sand, which name will not be used hereafter.
[b] Mapped as Sunnyside sand, which name will not be used hereafter.

	Acres.		Acres.
Baker City, Oreg	10,816	Walla Walla, Wash	64,896
Lewiston, Idaho	6,208	Yakima, Wash	149,580

Yakima fine sandy loam.—The surface soil is a mellow, friable, brown sandy loam from 10 to 16 inches deep. The subsoil consists of a light-brown silty loam, heavier and more plastic than the surface soil. The type is easily tilled and well drained. Generally occupies rolling hills. Wheat is the principal crop.

	1	2	3	4
Soil (11)	2	16	72	10
Subsoil (7)	1	12	76	10

	Acres.
Lewiston, Idaho	172,992
Walla Walla, Wash	26,688

Yakima loam.—Loamy soil 2 to 6 feet in depth, sometimes overlying sandy loam or sand, but often resting directly on coarse gravel. Not well drained. Usually free from alkali. Alluvial soil. Hay and pasture land.

	1	2	3	4
Soil (7)	4	29	51	14
Subsoil (6)	8	30	43	18

	Acres.		Acres.
Baker City, Oreg	29,760	Boise, Idaho	[a] 1,500
Blackford, Idaho	241,216	Walla Walla, Wash	3,392

Yakima silt loam.—A grayish-blue, brown, or black loam, ranging from a fine sandy to a heavy silty texture, and about 10 inches deep, underlain by a dark-gray or bluish loam with adobe tendencies. This is in turn underlain by a lighter material, occasionally of a yellowish cast, containing some sand. Occupies valleys and is generally quite level. Formed by weathering of sediment washed from hills of Yakima fine sandy loam. Wheat forms the principal crop. Timothy, barley, oats, and alfalfa are also grown.

	1	2	3	4
Soil (3)	4	12	68	15
Subsoil (3)	3	19	64	14

	Acres.
Lewiston, Idaho	15,936

[a] Mapped as Caldwell loam, which name will not be used hereafter.

REDFIELD SERIES.

This series is derived from disintegration of red sandstone and usually occupies valley areas.

Redfield sandy loam.—Red sandy loam, 6 feet in depth. Soil derived from disintegration of red sandstone, and is usually well drained. In certain areas soil contains gravel within 3 feet of surface, and this gravel increases in amount and size in lower depths. Valley floor sloping gently toward the mountains, or upper bench lands. Adapted to alfalfa and grain, when so situated that irrigation is possible.

	1	2	3	4
Soil (8)	8	43	30	13
Subsoil (13)	6	43	32	11

	Acres.
Laramie, Wyo.	42,624
Sevier Valley, Utah	44,200

Redfield loam.—Vermilion-colored loam, 5 feet deep, underlain by clay to a considerable depth. Poorly drained soil, containing large quantities of alkali. Level valley floor. Excellent land for general farming purposes when drained and free from alkali.

	1	2	3	4
Soil (2)	1	19	52	22
Subsoil (4)	2	21	48	21

	Acres.
Sevier Valley, Utah	14,100

Redfield clay loam.—Clay 5 feet in depth, of vermilion-red color, underlain by sand. Clay is quite tenacious and difficult to till. Poorly drained soil, containing considerable alkali. Low and level valley land. Of little agricultural value except as meadow land.

	1	2	3	4
Soil (2)	2	10	53	27
Subsoil (4)	0	9	52	39

	Acres.
Sevier Valley, Utah	3,800

OXNARD SERIES.

This series is formed from sandstone and shale material and is found mainly on delta plains.

Oxnard sand.—Brownish sand, consisting chiefly of quartz particles, medium to fine in texture, 6 feet or more in depth. Occurs

on river deltas. When first cultivated is shifted by the wind, and in Ventura County, Cal., protection by wind-breaks of trees is necessary. The grains of sand have been somewhat rounded by wind action. This soil is best adapted to lima beans and English walnuts, which are grown both with and without irrigation. On alkaline areas sugar beets are successfully grown. Barley and corn are also grown.

	1	2	3	4
Soil (3)	29	51	13	8
Subsoil (2)	50	32	11	9

	Acres.
Los Angeles, Cal	35,840
Ventura, Cal	16,200

Oxnard sandy loam.—Brown or black, mellow, loose, friable, open soil of peculiar woody feel, 4 to 5 feet deep, underlain by heavy sandy loam or loam. Derived from waste from sandstone and shale hills. Occurs on delta plains. When free from alkali, adapted to lima beans and sugar beets; when alkaline, adapted to sugar beets and barley. Generally well drained, but frequently containing a harmful quantity of alkali salts.

	1	2	3	4
Soil (1)	27	38	18	13
Subsoil (1)	6	30	28	31

	Acres.
Ventura, Cal	53,200

Oxnard loam.—Heavy, sticky, brown or black loam, underlain at 3 or 4 feet by a compact and heavier phase of the same soil. Derived from wash from shales and sandstones, and laid down in delta plains. Adapted to barley and sugar beets. Frequently needs draining.

	1	2	3	4
Soil (7)	5	23	39	32
Subsoil (7)	6	23	36	34

	Acres.
Los Angeles, Cal	19,520
San Jose, Cal	4,224
Ventura, Cal	6,830

Oxnard silt loam.—Brown, friable, silt loam, 6 feet or more in depth, derived from finer sediments of streams draining sandstone areas, mixed with particles of organic matter. Occurs in level delta plains. Adapted to lima beans, corn, and barley with-

out irrigation, and to lima beans, walnuts, and deciduous and citrus fruits when irrigated. Well drained and free from alkali salts.

	1	2	3	4
Soil (2)	2	16	58	25
Subsoil (3)	1	14	52	30

	Acres.
San Jose, Cal	25,920
Ventura, Cal	5,320

SOILS ASSOCIATED WITH THE OXNARD SERIES.

Salinas shale loam.—Very light, chalklike loam, 5 to 6 feet in depth, grading into loam of texture of Oxnard loam. Light, friable, and easily cultivated; sometimes contains large percentage of light siliceous gravel, derived from the beds of bituminous shale of Miocene age. Occurs on level, gently sloping plains near mountains. Always well drained and free from alkali. Adapted to Lady Washington and black-eyed beans and barley.

	1	2	3	4
Soil (3)	4	21	51	20

	Acres.
Lower Salinas Valley, Cal	13,730
Ventura, Cal	2,544

Fullerton sandy adobe.—Brown sandy adobe to a depth of 5 feet, underlain by compact sand or sandstone. Residual material derived from weathering of underlying shaly sandstone. Foothills extending down into level valley lands. Dry farmed to wheat, and when irrigated used to some extent for citrus fruits.

	1	2	3	4
Soil (3)	4	36	36	22
Subsoil (2)	2	40	36	20

	Acres.
Los Angeles, Cal	7,040
Santa Ana, Cal	31,334
Ventura, Cal	1,940

BILLINGS SERIES.

The soils of the Billings series are derived from the disintegration of sandstone and shale.

Billings gravelly loam.—A sandy loam 0 to 18 inches deep, underlain by loam or light clay loam 3 feet deep, both containing gravel,

beneath which is found waterworn gravel. Found in terraces which were formerly river banks. Is free from alkali and well drained. Where occurring on plateau is well adapted to grain and alfalfa.

	1	2	3	4
Soil (2)	7	32	36	26

	Acres.
Billings, Mont	11,776

Billings sandy loam.—A loam 0 to 12 inches deep, underlain by light yellow sandy loam 3 to 15 feet deep, under which is found sandstone fragments, gravel, or sand. Tills very easily. Occupies hills. Is derived from disintegrated sandstone. Underdrainage good. Adapted to all crops of the valley.

	1	2	3	4
Soil (1)	1	61	22	12
Subsoil (2)	2	75	13	11

	Acres.
Billings, Mont	13,568

Billings loam.—A gray to black sandy loam, 0 to 12 inches deep, underlain by loam or light clay loam to a depth of from 2 to 6 feet, beneath which is usually found a sandy loam or sand, and occasionally gravel. The surface is generally level. The type is derived from Fort Benton shale and limestone. Adapted to grain and vegetables, and in some localities to fruit.

	1	2	3	4
Soil (1)	1	27	40	31
Subsoil (2)	2	32	39	27

	Acres.
Billings, Mont	14,144

Billings clay.—Consists of a loam 0 to 12 inches deep, underlain by a tough, sticky, impervious dark-gray to black loam 3 to 12 feet deep. Formed by disintegration of Fort Benton shale. The surface becomes very hard when dry and the type is difficult to till. Best adapted to grass for pasturage and hay.

	1	2	3	4
Soil (3)	1	19	37	43
Subsoil (4)	2	17	38	44

	Acres.
Billings, Mont	17,088
Laramie, Wyo	16,064

Laurel sandy loam.—An alluvial sandy loam 2 to 6 feet deep, light-yellow to black in color, underlain by gravel and sand at lower depths. Surface usually level, cut by sloughs and old river channels, and swampy areas due to seepage from irrigating ditches. Derived from deposits of the Yellowstone River. Except in parts affected by alkali, is excellent for growing grain, vegetables, and fruits.

	1	2	3	4
Soil (4)	11	50	29	12
Subsoil (4)	29	49	15	7

	Acres.
Billings, Mont	8,832
Laramie, Wyo	29,440

SALT LAKE SERIES AND ASSOCIATED SOILS.

The Salt Lake series occurs in old glacial lake beds, particularly around Great Salt Lake and Utah Lake. It is probable that this series is related to the Maricopa and Fresno series, as the material is of the same granitic origin.

Salt Lake sand.—Sand consisting of about 80 per cent of medium-sized egg-shaped or spherical particles, largely calcareous. Occupies level or dune areas. Near Great Salt Lake, Utah, soil is derived from the breaking up of lime hardpan, the peculiar and regular shape of the particles resulting from the wearing and polishing action of wind and water. As found in the vicinity of Great Salt Lake the soil is of no agricultural value because of its limited extent and its position.

	1	2	3	4
Soil (2)	65	32	1	2

	Acres.
Provo, Utah	1,152
Salt Lake, Utah	1,140

Salt Lake sandy loam.—Sandy loam 2 feet deep, underlain by fine sand. Level plains, recent lake bottoms. Soil is poorly drained, contains an excess of alkali, and is bare of vegetation. For these reasons it has no present agricultural value.

	Acres.
Weber County, Utah	49,900

Jordan sandy loam.—Sandy loam 2 feet deep; loam to 4 feet; sand to 5 feet, underlain by clay. Level plains, generally well

drained. Derived from lacustrine deposits and river sediments. When well drained and free from alkali it is recognized as one of the best of soils for general agricultural purposes and such crops as grain, alfalfa, and fruit.

	1	2	3	4
Soil (11)	8	41	33	16
Subsoil (6)	2	36	38	23

	Acres.
Provo, Utah	38,400
Salt Lake, Utah	48,620

Jordan loam.—Loam 3 feet deep, underlain by stiff, tenacious clay. Level low-lying plains. Origin, lacustrine, or river deposits, in Salt Lake and Sevier counties, Utah. Generally contains alkali. When free from alkali and well drained this soil is good for alfalfa and grain crops.

	1	2	3	4
Soil (12)	3	25	38	28
Subsoil (11)	6	29	35	24

	Acres.
Provo, Utah	99,648
Salt Lake, Utah	41,900
Weber County, Utah	15,400

Salt Lake loam.—Loam 2 feet deep, underlain by sandy loam. Level plains, representing recent lake bottom, poorly drained, containing excessive amounts of alkali. Soil is not adapted to agriculture at present on account of low-lying position, imperfect drainage, and high salt content.

	1	2	3	4
Soil (2)	3	40	31	28
Subsoil (2)	1	69	18	12

	Acres.
Provo, Utah	3,456
Weber County, Utah	9,600

Jordan clay.—Tenacious clay or clay loam 6 feet or more in depth. Level, low-lying plains, poorly drained, generally containing large quantities of alkali. Origin, lacustrine deposits. This soil has little present agricultural value, on account of poor drainage, general occurrence of alkali, and impervious nature of the material.

	1	2	3	4
Soil (4)	5	16	30	49
Subsoil (7)	9	12	36	43

	Acres.
Provo, Utah	3,840
Salt Lake, Utah	18,510

PECOS SERIES AND ASSOCIATED SOILS.

These soils are derived from lacustrine deposits and stream wash, and are usually very calcareous.

Pecos conglomerate.—Sandy loam to a depth of 2 feet, containing a high percentage of rounded gravel, resting upon conglomerate or gravel beds. Bench land and bluffs. Soil derived from disintegration of conglomerate beds; well drained and free from alkali salts; readily transmits seepage waters. Not adapted to any agricultural purpose at present.

	1	2	3	4
Soil (2)	3	56	17	18

	Acres.
Pecos Valley, N. Mex	11,680

Pecos sand.—Fine sand, 6 feet or more in depth, except where drifted over other formations. Lies along rivers by which it has been transported from the mountains. The action of the wind has extended the areas, and the surface is usually covered with dunes. The soil is calcareous and contains small amounts of alkali, though not enough to injure plants. Characteristic vegetation: Mesquite, willow, canaigre, yucca, and cottonwood. Generally well drained. Adapted to truck, fruit, melons, potatoes, and root crops.

	1	2	3	4
Soil (1)	1	55	37	7
Subsoil (1)	2	62	33	3

	Acres.
Pecos Valley, N. Mex	2,810
Salt River Valley, Ariz	13,960
Solomonsville, Ariz	6,720

Pecos sandy loam.—Soil is a fine-grained gray sandy loam, 30 inches deep; subsoil is a gray light loam, slightly heavier than the soil. Occupies high, level valley land. Derived from lacustrine deposits; well drained and generally free from alkali. Recognized as the best general farming land.

	1	2	3	4
Soil (7)	3	46	25	18
Subsoil (1)	0	36	27	31

	Acres.
Pecos Valley, N. Mex	24,770
Roswell, N. Mex	11,540

Roswell sandy loam.—Heavy gray sandy loam 12 inches deep; subsoil is a light loam underlain by clay at a depth of 5 feet. Level second-bottom land derived from lacustrine deposits, poorly drained, often containing alkali. Recognized as good farming land.

	1	2	3	4
Soil (3)	1	48	24	16

	Acres.
Pecos Valley, N. Mex	9,090

Roswell loam.—Loam, 4 feet deep, underlain by clay loam and clay. Level, low bench land. Lacustrine deposit. Soil is naturally poorly drained and contains alkali, but when well drained and free from alkali it is recognized as good soil for general farm crops.

	Acres.
Pecos Valley, N. Mex	2,730

IMPERIAL SERIES.

This is an important group of soils found in the Colorado Delta.

Imperial gravelly loam.—A gravelly loam about 2 feet deep, underlain by clay to a depth of 6 feet or more. In some areas the interstitial material becomes quite sandy. The gravel consists of agate, quartz, chert, limestone, granite, obsidian, and indurated clay, varying in size from 1 inch to 5 or 6 inches in diameter. Represents old beach lines or alluvial cones. In the lighter phases the soil contains little alkali, but elsewhere the alkali content is high. Too rough for cultivation. Subject in places to destructive erosions by mountain floods. Much of it lies too high for cultivation. When irrigable and not too alkaline, suitable for fruits and vegetables.

	1	2	3	4
Soil (1)	23	53	7	16
Subsoil (1)	7	17	25	51

	Acres.
Imperial, Cal	43,328

Imperial sand.—Fine sand 5 feet deep, underlain by loam or clay. The sand is generally well drained and free from harmful quantities of alkali, but the loam or clay subsoil contains alkali in excess, which will rise to the surface, to the detriment to the land.

should excessive irrigation be practiced. This soil is adapted to any of the crops suitable to the climate.

	1	2	3	4
Soil (4)	11	74	11	4
Subsoil (2)	1	53	24	20

	Acres.
Imperial, Cal	1,792
Yuma, Ariz	9,062

Imperial sandy loam.—A fine-grained sandy loam, 3 feet deep, underlain by clay or loam, formed by deposition of coarsest sediments carried by Colorado River. Surface irregular and covered with dunes. Where free from excessive alkali the soil is adapted to any crop suitable to southern arid regions.

	1	2	3	4
Soil (12)	0	30	50	16
Subsoil (9)	0	24	43	28

	Acres.
Imperial, Cal	126,656
Yuma, Ariz	12,806

Imperial loam.—A fine-grained sticky loam, on an average 5 feet deep, underlain by clay or clay loam. A very fertile soil, but frequently contains an excess of alkali salts. Drainage of this soil is costly and difficult on account of its close grain. When free from alkali it is adapted to most of the crops suited to the climate, but as it is likely to pack, annual crops or cultivated crops will prove most profitable.

	1	2	3	4
Soil (7)	0	13	52	32
Subsoil (5)	0	7	51	38

	Acres.
Imperial, Cal	341,056
Yuma, Ariz	20,800

Imperial clay.—Soil is a heavy clay loam or clay, having a depth of 6 feet or more. Surface usually level, though in places small dunes are seen. Derived from deposition of finest sediment of the Colorado River. When dry and in its natural state it exists in hard cakes and lumps. After irrigation the soil dries very hard and cracks intersect the surface in all directions. Difficult to till. Little under cultivation. Sorghum and millet produce good crops.

	1	2	3	4
Soil (13)	1	11	36	49
Subsoil (10)	1	11	35	52

	Acres.
Imperial, Cal	33,792

SALEM SERIES.

Soils of this series are derived from interbedded layers of sandstone, argillaceous and schistose rocks and a dense, close-grained basalt, all highly ferruginous.

Salem gravelly loam.—Brown or black loam containing a large amount of gravel from 2 to 3 inches in diameter. This grades imperceptibly into a soil of the same material but containing more gravel. A bottom soil generally well drained. Derived as a stream wash from the same material as the Salem clay. Where not too gravelly the soil is fairly well adapted to grain and fruit.

	Acres.
Salem, Oreg	13,120

Salem sandy loam.—Brown sandy loam of medium texture, 12 inches deep, underlain by a coarse sandy loam grading into sand. The surface soil usually contains considerable organic matter. A bottom soil, subject to frequent overflow. Well drained when the river is at normal stage. Forms an excellent truck soil. Gives large yields of hops, but they are subject to disease.

	1	2	3	4
Soil (1)	5	67	16	13
Subsoil (1)	2	72	15	11

	Acres.
Salem, Oreg	3,648

Salem loam.—Brown to black loam 18 to 24 inches deep, containing considerable organic matter, and being usually quite silty. The subsoil is yellowish or red-clay loam or clay, becoming heavier with depth, and often becoming mottled with gray and yellow. Gently rolling or level valley land derived from transported sandstone material, with some basalt. Drainage generally good. Soil is well adapted to general crops as well as to hops and small fruits. Wheat produces from 25 to 30 bushels, oats from 35 to 60 bushels, and hops about 15,000 pounds per acre.

	1	2	3	4
Soil (2)	3	10	62	25
Subsoil (2)	2	9	66	24

	Acres.
Salem, Oreg	78,656

Salem clay.—Heavy red loam or clay, 12 to 15 inches deep, resting on a red clay. Derived from red sandstone, argillaceous and schistose rocks, and a dense, close-grained ferrous basalt, all highly ferruginous. Occurs on rolling hills, generally well drained. Fertile soil, adapted to wheat, oats, hops, apples, prunes, and peaches. Hops are less subject to mold and insect pests than those grown on the bottom soils. The grain is of fine quality. Wheat yields from 25 to 30 bushels and oats from 30 to 60 bushels per acre. Hops yield about 1,200 pounds per acre.

	1	2	3	4
Soil (1)	11	18	26	45
Subsoil (1)	10	17	24	49

	Acres.
Salem, Oreg	86,400

SAN LUIS SERIES AND ASSOCIATED SOILS.

The soils are derived from lacustrine deposits of volcanic rock materials.

San Luis sand.—A very coarse, incoherent, loose, reddish-brown sand containing a large proportion of fine gravel, underlain at a depth of from 2 to 4 feet by a coarser material which can not be penetrated with the auger. The soil is composed of minute fragments of volcanic rock, and is light and easily shifted by the wind. In origin it is without doubt a lacustrine deposit and the generally level surface is crossed by minor ridges thought to be the result of varying deposition taking place in currents of different velocities. There are also some dunes from 1 to 6 feet high. These irregularities are a great hindrance to cultivation and irrigation. The drainage is excessive and constant irrigation is necessary. This has swamped some areas, and brought about the rise of alkali over large tracts of the type. Much of the originally productive land has been abandoned for this reason. Fair crops of the small grains are grown. The yield per acre of wheat is 15 to 30 bushels, of oats from 20 to 40. Pease are grown for pasture and for hay.

	1	2	3	4
Soil (4)	51	32	10	8

	Acres.
San Luis Valley, Colo	136,960

San Luis sandy loam.—A coarse, gravelly, reddish-brown loam from 18 inches to 3 feet deep, resting on a subsoil of almost pure gravel and sand, which extends to indeterminate depths. Near the mountains the surface soil is shallower, more sticky, and the gravel larger and more waterworn. Heavier phases of the soil are known locally as "adobe." Occupies imperceptibly sloping plains, the surface of which is broken by many knolls and ridges from 8 inches to not more than 2 feet in height. Soil is a lacustrine deposit. Near the mountains the soil is well drained and free from alkali. Lower areas are alkaline. Nearly all the cultivated areas are sown to cereals and pease. Well adapted to these crops, and also to potatoes and truck crops.

	1	2	3	4
Soil (3)	35	31	20	13
Subsoil (1)	8	34	52	6

	Acres.
San Luis Valley, Colo	196,992

San Luis loam.—A plastic and sticky, reddish-brown loam, containing some gravel, 24 to 36 inches deep, resting on a subsoil of sand or sandy loam, beneath which occurs sand and gravel. The surface is level and uniform and well adapted to irrigation. Lacustrine deposit formed by further breaking down of materials of San Luis sandy loam. Contains more or less alkali, and is not at present cultivated. When irrigated, produces a good crop of wild hay. Would be well adapted to the grain crops.

	1	2	3	4
Soil (1)	15	39	12	34

	Acres.
San Luis Valley, Colo	9,088

Rio Grande sandy loam.—Dark-brown to black, friable, easily cultivated sandy loam, with an average depth of about 2 feet, resting on a bed of gravelly sand. Occurs as narrow strips along river. The surface is generally level. The drainage usually poor. Potatoes succeed very well, and the production of these and native pasturage are about the only uses made of the soil.

	1	2	3	4
Soil (2)	10	36	34	22

	Acres.
San Luis Valley, Colo	35,776

Rio Grande loam.—A sticky, plastic, black loam, containing considerable gravel, resting on a subsoil of sand and gravel which extends to undetermined depths. Soil contains considerable organic matter. Found along small streams near the mountains and in depressions. Formed partially from materials brought by the streams from the mountains, and partially by the further disintegration of the materials forming the San Luis sandy loam, namely, lacustrine deposits of volcanic origin. The soil is very difficult to cultivate. When wet, it is a sticky mass of mud, and when dry, it bakes similarly to the adobes of the Pacific coast. It is not esteemed a very desirable soil for grain or alfalfa. At present is used mainly for pasturage. The drainage is rather poor and would be difficult to improve.

	1	2	3	4
Soil (4)	10	23	36	31

	Acres.
San Luis Valley, Colo	23,104

MISCELLANEOUS SOILS OF THE FAR WEST.

Salt River gravel.—Coarse gravel of undetermined depth. Bluff along Salt River, Arizona. Of no present agricultural value.

	Acres.
Salt River Valley, Ariz	1,804

Arroyo Seco sandy loam.—Dark-brown or yellowish coarse sandy loam, containing a large percentage of coarse, well-rounded gravel and small bowlders of granitic origin. Sometimes becoming compact and very hard at surface. Found upon gently sloping fans. Derived from stream wash from mountains. Somewhat deficient in organic matter. Adapted to grains if well irrigated, but irrigation is very difficult, on account of loss by seepage through coarse subsoil. Yield fair in favorable seasons. Free from alkali.

	1	2	3	4
Soil (2)	29	36	23	12

	Acres.
Lower Salinas Valley, Cal	9,570
San Jose, Cal	7,616

Laramie gravelly loam.—Coarse sandy loam containing a large amount of gravel, 6 feet or more in depth. At from 6 to 10 feet underlain by yellow shale. Has no agricultural value.

	Acres.
Laramie, Wyo	19,200

Laramie sandy loam.—Coarse sandy loam from 2 to 6 feet deep, underlain by sand and gravel. Some gravel found scattered through the surface soil, generally quartz, sandstone, and limestone rock. Upland soil of colluvial origin. Well adapted to general farm crops. Wheat yields from 20 to 30 bushels, oats from 30 to 50 bushels, potatoes from 100 to 175 bushels, and alfalfa about 4 tons per acre.

	1	2	3	4
Soil (2)	27	37	12	26
Subsoil (3)	25	33	16	27

	Acres.
Laramie, Wyo	82,272

Los Angeles sandy loam.—Brown sandy loam 2 to 3 feet deep, grading into disintegrated sandstone and shale. Rough, hilly country. Some grain is grown under dry farming, but soil is not well adapted to crops.

	1	2	3	4
Soil (2)	10	35	37	18
Subsoil (2)	13	37	37	14

	Acres.
Los Angeles, Cal	9,024

Fancher sandy loam.—Dark-red micaceous sandy loam 6 feet or more in depth, derived from stream wash from foothills, well drained and free from alkali, containing relatively high percentage of organic matter. Occupies foothill stream bottoms and sinks. Generally adapted to fruit and vineyards.

	1	2	3	4
Soil (8)	19	42	23	11
Subsoil (3)	27	45	19	6

	Acres.
Fresno, Cal	12,832
Hanford, Cal	19,860

San Joaquin sandy loam.—Reddish light sandy loam 3 feet in depth, frequently hard and compact, underlain by red sandstone hardpan. Along foothill streams hardpan is absent, the sandy

loam extending to a depth of 6 feet or more. Generally occupies sloping valley plains. Soil is derived from disintegration of red sandstone rock. Well drained, free from alkali, and frequently covered with hog-wallow mounds. Adapted to grain crops, and, where hardpan is more than 3 feet from the surface, to fruits and vineyards.

	1	2	3	4
Soil (9)	27	44	18	9

	Acres.
Fresno, Cal	74,547

Placentia sandy loam.—Sandy loam 3 feet in depth, underlain by sandy adobe. Surface material is compact and grades into the sandy adobe. High mesa land, valley lands, and high plains and rolling hills; remnant of old flood plain subsequently modified by wind action. Well drained and free from alkali. At present adapted to citrus and other fruit when water supply is available; dry farmed, to wheat, barley, and black-eyed beans.

	1	2	3	4
Soil (10)	14	38	34	13
Subsoil (7)	12	40	33	14

	Acres.		Acres.
Lower Salinas Valley, Cal	74,000	San Jose, Cal	61,568
Los Angeles, Cal	66,048	Santa Ana, Cal	16,857
San Gabriel, Cal	48,820	Ventura, Cal	23,880

Santiago sandy loam.—Sandy loam 3 feet deep, underlain by sand to 5½ feet, which is in turn underlain by sand and gravel. Over a considerable area the gravel comes to the surface and increases in size and amount in the lower depths. Lower delta plains of the foothill streams in Orange County, Cal. Dry-farmed to wheat and barley, and under irrigation at present adapted to fruits of that locality.

	1	2	3	4
Subsoil (1)	12	51	27	7

	Acres.
Santa Ana, Cal	17,100

Elsinore sandy loam.—Light-colored sandy loam 4 feet in depth, underlain by coarse sand, grading into gravel. Low, level portions of Sevier Valley, Utah. Derived from river-transported ma-

terial; poorly drained and contains considerable alkali near the surface. At present adapted only to salt-grass meadows.

	1	2	3	4
Soil (7)	8	39	36	10
Subsoil (12)	18	47	24	6

	Acres.
Boise, Idaho	[a]33,100
Sevier Valley, Utah	7,800

Boise sandy loam.—Light-gray, flaky, ashy-textured sandy loam, micaceous, loose, and powdery. From a few inches to 40 or 50 feet in depth. Surface, 6 feet, often interstratified with loam soil and sand or sandy loam lime hardpan, but in places sandy loam extends to bed rock. Soil rests on coarse gravel and cobbles. Some alkali in local spots in loam subsoil. Usually found on mesas. Lake sediment, probably derived from basalt. Well drained. Adapted to truck, grain, and clover. Where the hardpan is not very thick, fruit and alfalfa do well.

	1	2	3	4
Soil (2)	2	19	67	8
Subsoil (7)	23	21	40	12

	Acres.
Boise, Idaho	95,850

Deer Flat sandy loam.—Fine red, micaceous, sandy loam, a few inches to 3 feet in depth. Subsoil, sandy loam and sand to perhaps 50 or 100 feet. Occurs in higher lying valley areas, and has a generally level surface. Free from alkali in areas mapped. Only small portion cultivated, owing to lack of water for irrigation. Good for truck, grain, clover, and fruit.

	1	2	3	4
Soil (2)	6	57	26	8
Subsoil (3)	7	58	23	8

	Acres.
Boise, Idaho	45,380

Gila fine sandy loam.—Fine sandy loam or very fine sand 6 feet or more in depth, derived from river deposits subsequently modified by wind action. Occupies low bluffs and plains. Adapted to alfalfa and grain crops.

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[a] Mapped as Caldwell sandy loam, which name will not be used hereafter.

	1	2	3	4
Soil (8)	1	44	42	11
Subsoil (1)	5	59	33	11

	Acres.		Acres.
Imperial, Cal	30,784	Solomonsville, Ariz	9,600
Salt River Valley, Ariz	18,578	Yuma, Ariz	17,038

Santiago loam.—Red loam, 3 feet deep; sandy loam to 4 feet, underlain by gravelly sandy loam. Harsh, compact soil washed from foothills by the streams; occurring along margin of coastal plain near foothills in southern California. Considered unproductive soil, and at present little used for agricultural purposes.

	1	2	3	4
Soil (1)	4	34	43	16
Subsoil (1)	4	30	42	21

	Acres.
Santa Ana, Cal	1,830

Glenwood loam.—Loam 4 feet deep, underlain by clay. Level valley floor. Soil contains considerable alkali, and drainage is often poor, but when drained and free from alkali it is excellent for general farming purposes.

	1	2	3	4
Soil (2)	3	17	46	28
Subsoil (3)	5	20	44	25

	Acres.
Sevier Valley, Utah	12,100

Boise loam.—Red or yellow loam from 6 inches to several feet in depth, underlain with alternating strata of sandy loam and sand, the latter often being cemented by calcium carbonate into a hardpan. Soil particles in the upper stratum of virgin soil also usually cemented together, but not into a compact mass. Surface is usually covered with a coating of sandy loam, varying in depth and having the texture of the Boise sandy loam. Occurs on mesa plains and is derived from lake sediments. Often alkaline. When subsoil is broken up, is good for fruit, grain, and alfalfa.

	1	2	3	4
Soil (1)	5	31	44	17
Subsoil (3)	11	32	34	19

	Acres.
Boise, Idaho	61,960

Walla Walla loam.—This type consists of a very sticky brown or black sandy loam, or loam, with a depth of 3 feet, underlain by a sandy loam similar to the subsoil of the Yakima sandy loam. In places this subsoil from 3 feet to 6 feet may be a sticky, yellow plastic sandy loam, but in most cases below 3 feet the soil is an ordinary sandy loam. Occupies the very high, steep hills in the eastern part of the district mapped. Is especially adapted to wheat and barley, giving very large yields of both.

	1	2	3	4
Soil (3)	1	15	69	14
Subsoil (3)	2	20	66	10

	Acres.
Walla Walla, Wash	23,360

Glendale loess.—Silt 6 feet or more in depth, typical loess texture. Level plain, forming low divide between Salt River and Agua Fria River, Arizona. Formed by wash from Cave Creek. Generally well drained and free from alkali. Adapted to grain and alfalfa; lighter phases to fruit growing.

	1	2	3	4
Soil (7)	3	27	42	29
Subsoil (2)	3	41	39	12

	Acres.
Salt River Valley, Ariz	52,040

Santiago silt loam.—The soil is a dense, heavy, silt loam resembling adobe, 2 feet in depth, very sticky when wet, underlain by sand, fine sand, or fine sandy loam. Lower delta plains and river terraces. Derivation from modern alluvium, often being deposited at present during flood season. When well drained and free from alkali this soil is adapted to fruit, celery, and sugar beets. It is dry-farmed to wheat to some extent, and as occurring in the Salinas Valley is considered a most valuable soil.

	1	2	3	4
Soil (12)	4	21	52	21
Subsoil (3)	2	25	56	14

	Acres.		Acres.
Los Angeles, Cal	39,360	San Gabriel, Cal	5,220
Lower Arkansas Valley, Colo	37,760	Santa Ana, Cal	14,349
Lower Salinas Valley, Cal	14,120	Yuma, Ariz	3,763

Salt River adobe.—Clay loam with adobe properties, 2 feet deep, underlain by sandy loam or loam. Low-lying land, containing alkali, and rather poorly drained. Sediment of prehistoric irrigation with muddy water. Generally adapted to alfalfa and small grain.

	1	2	3	4
Soil (5)	4	30	31	28
Subsoil (3)	2	44	25	24

	Acres.
Salt River Valley, Ariz.	13,665

Sierra adobe.—Sandy adobe containing small amounts of gravel to a depth of 2 or 3 feet, generally underlain by red sandstone, hardpan, or granite rock. Low foothills. Residual soil derived from decomposition of underlying granite, used to some extent for dry-farming wheat and barley.

	1	2	3	4
Soil (2)	11	42	33	14
Subsoil (1)	12	27	33	28

	Acres.
Fresno, Cal.	13,376
Los Angeles, Cal	6,976

GYPSUM SOILS.

Gypsum.—Light-brown or reddish-brown sandy loam or loam soil, underlain by soft saccharoidal gypsum at a depth of from a few inches to 6 feet. Gypsum is often present at the surface. Level bench land. Derived from disintegration of gypsum deposits and possesses remarkable power of transmitting seepage waters by capillary and gravitational flow. With high salt content of irrigation water it is not desirable land for agricultural purposes. Often contains large quantities of alkali.

	1	2	3	4
Soil (2)	3	50	24	18
Subsoil (5)	3	33	19	38

	Acres.
Pecos Valley, N. Mex.	[a]11,630
Laramie, Wyo	2,304

[a] Mapped as Pecos gypsum, which name will not be used hereafter.

PORTO RICAN SOILS.

Riverwash.—Coarse sand, gravel, and bowlders, generally in long, narrow areas, but occasionally spread out in fan-shaped areas, subject to overflow in times of flood. Of little or no agricultural value.

	Acres.
Arecibo to Ponce, P. R.	970

Portugues stony loam.—Dark loam 14 inches in depth, derived from igneous and volcanic rocks. Contains 5 to 70 per cent of angular stones, and is underlain by cracked and broken volcanic and igneous rock partly decomposed. Occupies steep slopes of hills and mountains, covering a large area between Ponce and Adjuntas. Used for pasture during the rainy season. Some coffee, bananas, and plantains are produced on favored areas.

	1	2	3	4
Soil (2)	37	20	24	19

	Acres.
Arecibo to Ponce, P. R.	15,600

Tanama stony loam.—Soil is a red clay loam, 6 to 10 inches deep, derived from limestone. Occupies large area of broken and rugged country between Arecibo and Utuado, characterized by local, swampy sink holes. Subsoil is a stiff red clay containing limestone fragments. Bananas and plantains are the principal crops, and some coffee, oranges, and a little tobacco are produced,

	1	2	3	4
Soil (3)	6	17	31	44
Subsoil (2)	12	32	16	40

	Acres.
Arecibo to Ponce, P. R.	41,680

Arecibo sand.—A loose, incoherent red to white coral and quartz sand, 12 to 36 inches or more deep. Occupies slightly rolling land. Soil is probably derived from wind-blown beach sand. Naturally poor soil. Similar to the Florida pineapple land. Produces some pasturage and a few cocoanuts.

	1	2	3	4
Soil (2)	54	42	4	2
Subsoil (1)	35	57	4	4

	Acres.
Arecibo to Ponce, P. R.	7,580

Coral sand.—Drifted, incoherent beach sand, 24 to 36 inches deep, formed from coral and shells by wind and wave action, underlain by a slightly loamy sand. Occupies low-lying lands on coast, occasionally forming slight hills 15 to 20 feet above sea level. Adapted to cocoanut trees.

	1	2	3	4
Soil (3)	62	30	4	4
Subsoil (1)	46	35	7	10

	Acres.
Arecibo to Ponce, P. R.	2,620

Arecibo sandy loam.—Heavy red sandy loam, with an average depth of 10 inches, underlain to a depth of 36 inches by a rather tenacious clay loam. Found in valleys between outlying limestone hills. Elevation between 30 and 100 feet. Naturally well drained. Used for truck and fruit. Small area devoted to tobacco and sugar cane.

	1	2	3	4
Soil (1)	23	57	6	14
Subsoil (1)	17	48	9	25

	Acres.
Arecibo to Ponce, P. R	2,690

Ponce sandy loam.—Brown sandy loam 14 to 36 inches or more in depth. An alluvial soil occupying river deltas in the vicinity of Ponce. The subsoil is a sandy loam heavier and darker than soil. Sugar cane is the principal crop. Cocoanuts and Guinea-grass also grown. There is a stony phase containing rounded stone fragments, sometimes as large as 2 or 3 feet in diameter. This phase is used only for pasture and at present has little value.

	1	2	3	4
Soil (6)	10	43	35	12
Subsoil (2)	2	22	57	20

	Acres.
Arecibo to Ponce, P. R	6,550

Utuado sandy loam.—Coarse, yellow sandy loam, 7 inches deep, representing soil of deforested area on steep slopes of the lower mountains around Utuado. Residual soil derived from igneous rocks. Subsoil is a shallow, yellow sandy loam, grading into decomposed granite and other igneous rocks. Little natural fertility, and but little used, as a great part of the areas are too steep for culti-

vation. Should be reforested. Produces a few bananas, some plantains, and coffee.

	1	2	3	4
Soil (1)	49	24	19	8
Subsoil (1)	47	27	17	8

	Acres.
Arecibo to Ponce, P. R	25,100

Vivi sandy loam.—Yellowish-brown sandy loam, 10 inches deep, forming tracts of alluvial deposits along the larger streams in the mountains near Adjuntas. Subsoil is a yellow-brown sandy loam. Soil is mellow and rich and easy to cultivate. Considered the best tobacco soil in the area. Also adapted to sweet potatoes, beans, and other minor crops. Used to a small extent in the production of sugar.

	1	2	3	4
Soil (2)	27	50	15	9
Subsoil (2)	13	44	25	19

	Acres.
Arecibo to Ponce, P. R	1,060

Arecibo loam.—A dark waxy loam, 6 to 12 inches deep, resting on a yellow sticky loam containing fragments of limestone. The soil is shallow as a rule, but fairly productive. Principally used for pasture near the coast. Inland areas devoted to bananas, plantains, and to some extent to coffee. A few orange trees were noticed, and appeared to be thrifty. Hardly 10 per cent of the area is in crops.

	1	2	3	4
Soil (2)	25	31	26	19
Subsoil (2)	22	26	26	26

	Acres.
Arecibo to Ponce, P. R	17,700

Pastillo loam.—White, reddish, or brown loam, about 4 inches in depth, resting on porous limestone, fragments of which occur in soil. Affords scanty pasturage. Produces small amount of Guinea-grass on areas of deeper and more fertile soil. Occurs west of Ponce, in the southern part of the Porto Rican area. Among the poorest soils of the area.

	1	2	3	4
Soil (2)	12	17	46	26

	Acres.
Arecibo to Ponce, P. R	16,040

Ponce loam.—Is composed of a dark-brown alluvial loam, 3 feet or more in depth. Originally swampy in part. When drained, well adapted to sugar cane and Guinea-grass, also to bananas and plantains. Best sugar land of the area. All under cultivation.

	1	2	3	4
Soil (1)	2	20	57	20

	Acres.
Arecibo to Ponce, P. R.	2,480

Utuado loam.—Dark-brown or yellowish loam, 7 inches deep, friable and free from stones, underlain by yellow loam becoming lighter in texture at lower depths. Derived from igneous and volcanic rocks. Occupies hilly country in vicinity of Utuado. Some areas adapted to coffee and fruit, but the greater part used for pasture.

	1	2	3	4
Soil (1)	11	28	28	34
Subsoil (1)	10	30	30	30

	Acres.
Arecibo to Ponce, P. R.	7,880

Arecibo silt loam.—Dark-brown silt loam, 12 to 36 inches deep, underlain by dark loam or silt loam. Alluvial deposit occupying low level areas along or near the coast. In the vicinity of Arecibo excellent cane land, producing from 30 to 40 tons per acre. Around Ponce, low lying and too alkaline for crops, on account of occasional inundation by sea water.

	1	2	3	4
Soil (4)	3	18	55	24
Subsoil (3)	3	14	52	31

	Acres.
Arecibo to Ponce, P. R.	8,960

Adjuntas clay.—A red or dark-brown clay, 3 to 15 inches deep, underlain by red clay 36 inches or more in depth. Derived from volcanic and igneous rocks. Occupies steep slopes. Difficult or impossible to till, requiring great care to prevent washing. The principal and most important coffee soil of the Arecibo to Ponce area. Also adapted to the growth of bananas, plantains, and oranges, where there is a sufficient depth of soil.

	1	2	3	4
Soil (3)	3	10	36	52
Subsoil (2)	3	11	43	43

	Acres.
Arecibo to Ponce, P. R.	29,890

Alonso clay.—Dark purplish-red clay loam, 8 to 28 inches deep, underlain by dark to purplish-red tenacious clay 36 inches or more in depth. Derived from igneous and volcanic rocks. Heavy, stiff, and hard to cultivate. Rough, mountainous topography. The small area southwest of Adjuntas is well adapted to oranges and coffee. The other areas are lower and produce chiefly bananas and plantains, with some coffee.

	1	2	3	4
Soil (5)	10	22	35	37
Subsoil (2)	4	15	37	44

	Acres.
Arecibo to Ponce, P. R.	13,690

Penuelas adobe.—Brown loam, with marked adobe properties, 13 to 15 inches deep, underlain by cracked and broken volcanic tufa. Derived from disintegrated volcanic tufa. Occupies hills and gentle slopes around Penuelas. Too dry except for pasture. Some bananas grown on moist spots.

	1	2	3	4
Soil (2)	14	18	28	41
Subsoil (1)	59	23	9	9

	Acres.
Arecibo to Ponce, P. R.	6,680

Portugues adobe.—Heavy, dark-brown or black loam resembling adobe, 6 to 17 inches deep, formed from decomposed limestone. Occupies parting valleys and gentle slopes around limestone hills in southern part of area. Soil is underlain by heavy light-brown loam, becoming lighter in color with increasing depth. Devoted chiefly to pasture, but produces sugar cane and bananas where irrigation is practicable. A large part of the area lies too high for irrigation.

	1	2	3	4
Soil (2)	6	20	32	33
Subsoil (2)	5	14	24	38

	Acres.
Arecibo to Ponce, P. R.	4,010

INDEX.

31896—04——12

SOILS ARRANGED BY STATES.